TECHNICAL MANUAL

OVERHAUL INSTRUCTIONS

STORAGE TANK, LIQUID NITROGEN TYPE TMU-35/E, 2000 GALLON CAPACITY

PART NO. 110700

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CRYENCO, INC.

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Page No.	Change No.	Page No.	Change No.	Page No.	Change No.
Title	0				
A	0				
i - vi	0				
1-0 - 1-4	0				
2-1 - 2-3	0				
2-4 Blank	0				
3-1 - 3-16	0				
4-1 - 4-2	0				
5-1 - 5-6	0				
6-1 - 6-5	0				
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8-2 Blank	0				
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10-1	0				
10-2	0				

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TABLE OF CONTENTS

TABLE OF CONTENTS--CONT.

LIST OF ILLUSTRATIONS

LIST OF TABLES

FOREWORD/PREFACE

Purpose. This technical manual will provide the using activity with repair and overhaul instructions for the 2000 gallon Liquid Nitrogen Storage and Transfer Tank, Type TMU-35/E.

Scope. This manual will provide the using activity with applicable information required on the disassembly, cleaning, inspection, repair, replacement, assembly, and testing associated with the use of cryogenic equipment and products. Any corrections regarding this technical manual should be submitted in accordance with T.O. 00-5-1.

Throughout this manual the unit will primarily be called the Tank. It may also be called the Storage Tank. Tanks referenced but not covered by this manual will contain additional descriptions. Example: supply tank and receiving tank. Liquid nitrogen may be referred to as the product, or abbreviated LN_2 in parts of this manual.

SAFETY SUMMARY

The following are general safety precautions and instructions that people must understand and apply during many phases of operation and maintenance to ensure personal safety and health and the protection of Air Force property. Portions of this may be repeated elsewhere in this publication for emphasis.

WARNING AND CAUTION STATEMENTS

WARNING and **CAUTION** statements have been strategically placed throughout this text prior to operationg or maintenance procedures, practices or conditions considered essential to the protection of personnel (**WARNING**) or equipment and property (**CAUTION**). a **WARNING** and **CAUTION** will apply each time the related step is repeated. Prior to starting any task, the **WARNINGS** or **CAUTIONS** included in the text for the task will be reviewed and understood.

QUALIFIED PERSONNEL

Only qualified personnel shall be authorized to operate and perform maintenance on this equipment.

PROTECTIVE EQUIPMENT

Personnel operating and performing maintenance on this equipment shall wear protective clothing and equipment as directed in T.O. 00-25-172.

BODILY CONTACT

Never allow liquid nitrogen or the cold piping on the equipment to contact the skin. The extremely low temperatures created by liquid nitrogen will immediately freeze the body area and result in severe frostbite.

EMERGENCY TREATMENT OF BODILY CONTACT

In the event of bodily contact with liquid nitrogen or the tank piping, remove the victim from the exposure immediately. Do not attempt to rewarm any body part as this should be accomplished by proper medical personnel. Transport the patient to an emergency room of a hospital or clinic as soon as possible. Keep the patient dry and warm enroute to the emergency room. Upon arrival, identify the injury as exposure to liquid nitrogen.

UNAUTHORIZED CONTAINERS

Never put liquid nitrogen in any container without proper safety devices (e.g. thermos bottle). When heated, liquid nitrogen will expand rapidly and build pressures to extremely high levels. The results of pressure buildup without safety devices may result in an explosion.

VENTILATION

Adequate ventilation must be provided for personnel for tank functions such as transfer operations, filling, draining, purging, painting, welding, brazing, and cleaning.

SAFETY SUMMARY--CONT.

LIFTING

Equipment used in lifting and moving the tank must be of sufficient rating to handle the weights involved.

PART CLEANLINESS

All parts used in liquid nitrogen service must be kept clean and free of hydrocarbons. Never use shop air to dry cleaned parts. Ultraviolet lights are used to check parts that have been cleaned. Overexposure to ultraviolet light can result in conjunctivitis (inflammation of the inner eyelid and eyeball) and possible skin burns which could result in skin cancer. Common hardware components not properly packaged that come in contact with liquid or gaseous product, shall be cleaned prior to use.

PURGING

When purging a tank all piping and valves become hot enough to burn. Ensure tank components are at ambient temperatures before attempting handling or removal after purging operations.

PURGE AND SPLASH HAZARDS

When discharging cryogenic liquids from service hoses, blow down lines or drain valves, open valves slowly to avoid being splashed by cryogenic product.

WELDING AND BRAZING

Welding or brazing operations produce heat, metal fumes, injurious radiation, metal slag, and airborne particles. Proper protective equipment must be worn before welding or brazing. Never look directly at the arc when welding or the flame during brazing. Never attempt welding or brazing operation near Teflon components (e.g. anti-seize tape). Teflon components deteriorate at high temperatures and emit poisonous gases. Proper ventilation is a must when welding or brazing.

TANK VACUUM

Never break the vacuum to air in the annular space, with or without liquid in the tank. The liquid must be drained and the tank warmed to ambient temperature. Break the vacuum to dry nitrogen gas.

CLEANERS/CHEMICALS/PAINTS/PRIMERS

Some cleaners, chemicals, paints, and primers have adverse effects on skin, eyes, and the respiratory tract. Observe manufacturer's Warning labels and current safety directives. Use only in authorized areas. Unless otherwise indicated in the text, use as described in this T.O. should not result in any immediate health concerns. Consult the local Bioenvironmental Engineer for specific protection equipment and ventilation requirements.

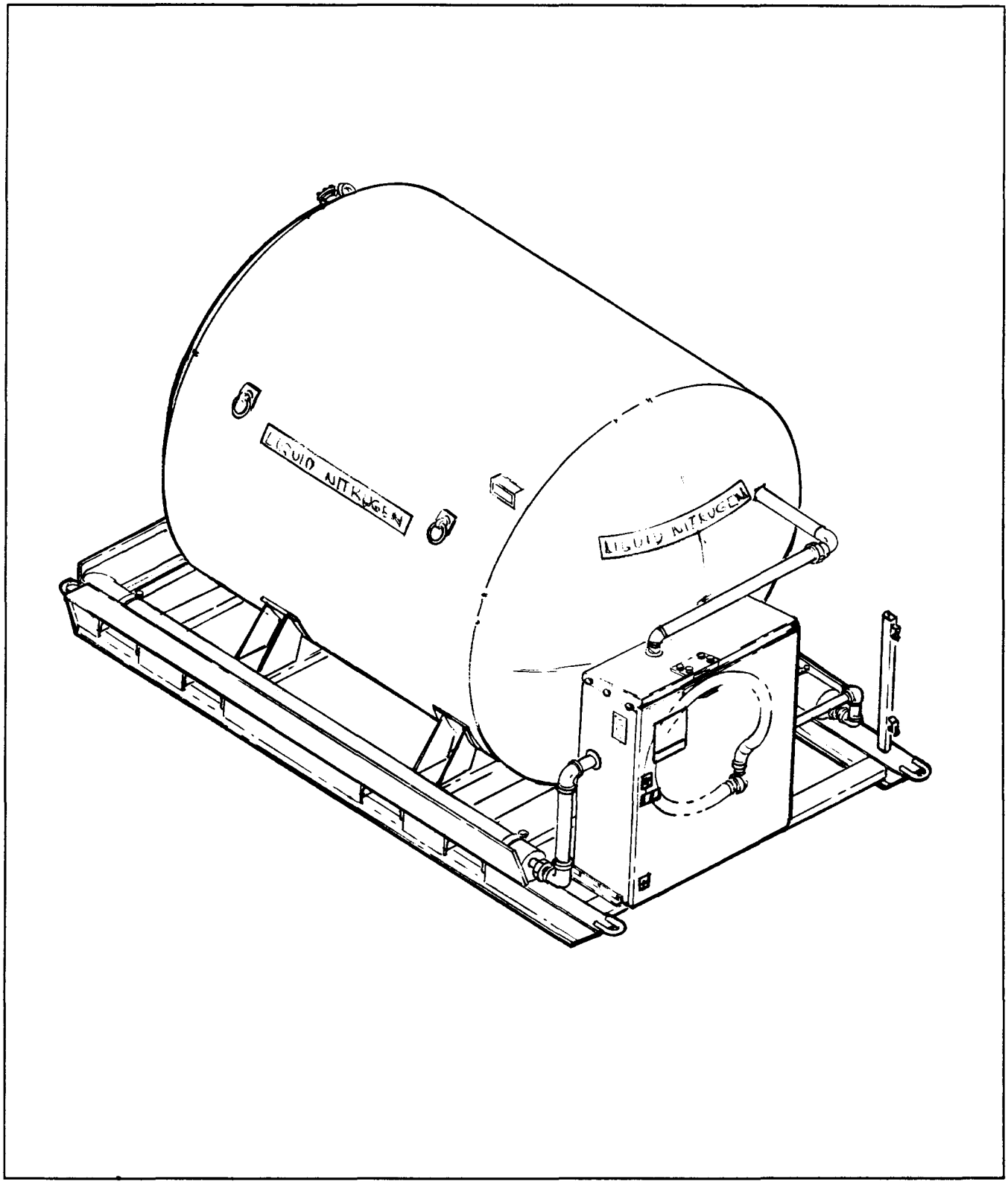


Figure 1-1. Tank, Storage, Liquid Nitrogen, Type TMU-35/E.

SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION.

This manual contains repair and overhaul instructions for the 2000 Gallon Liquid Nitrogen Storage and Transfer Tank, Type TMU-35/E, Part No. 110700, manufactured by Cryenco Inc., Denver, Colorado. Throughout this manual, the 2000 Gallon Liquid Nitrogen Storage and Transfer Tank (Figure 1-1) will be referred to as the storage tank. These instructions enable the user to disassemble the equipment, repair and replace defective parts, perform cleaning and inspection procedures, then, reassemble and test the equipment to ensure that it is in serviceable condition. All repairs must be conducted in a well-ventilated area to prevent a concentration of vapors from venting and spills. All safety precautions must be followed.

1-2. PURPOSE OF EQUIPMENT.

The storage tank is intended for use in storing liquid nitrogen and transferring it to the aircraft servicing system. It will store up to 2000 gallons of product at its atmospheric boiling temperature (-320°F). The storage tank must be empty when transported.

1-3. EQUIPMENT DESCRIPTION.

The storage tank is a complete, air transportable, self-contained unit, consisting of a 2000-gallon cryogenic storage tank, controls, indicators and appropriate piping for the receiving and transfer of liquid nitrogen. Table 1-1 presents the leading particulars for this assembly.

1-3.1. Tank Assembly. The tank assembly consists of an inner vessel for the containment of liquid nitrogen, suspended inside an outer vessel or jacket. The inner vessel is wrapped with layers of aluminum foil and glass paper, and isolated from the outer jacket by an annular vacuum space. In essence, the tank portion of the storage tank is a large Dewar, flask or thermos bottle.

1-3.2. Vacuum Seal-Off Valve. The vacuum seal-off valve, or evacuation valve, is at the top rear surface of the tank assembly. It is a standard diaphragm valve assembly, designed for the withdrawal of air from the annular space.

1-3.3. Control Housing (See Figure 3-6). The control housing is mounted at the front of the storage tank for the protection of the major controls, piping and instrument panel assembly. A hinged door provides access to controls and instrument panel. The liquid level gage and pressure gage are mounted on the instrument panel.

1-3.4. Fill/Drain Assembly See Figure 3-5). The fill/drain assembly is located in the middle of the control housing and extends through the right side of the control housing. It consists of fill/drain line shutoff valve (V-6), pressure buildup coil control valve (V-7) and associated piping. The right side of the fill/drain assembly connects to the PBU assembly and the left side connects to the fill/drain line filter (F-2).

1-3.5. Service Hose and Piping (See Figure 3-7, Detail B). The service piping, located on the lower right of the control housing, terminates into the service hose assembly and consists of an elbow and nipple. The nipple is connected to the service line filter, inside the control housing. The service line filter is supported by a u-bolt retainer.

1-3.6. Pressure Buildup Unit (PBU) or Coil (See Figure 3-7, 1). The pressure buildup coil is a tube type heat-exchanger. It is routed around both sides and rear end of the tank. Liquid product is admitted to the coil, where it expands as it assumes a gaseous form and provides transfer pressure to the tank.

1-3.7. Vent Line Assembly (See Figure 3-4). The vent line assembly is located in the upper part of the control housing and extends through the left side and the top of the control housing. It consists of relief valve (RV-3), rupture disc (SD-1), vapor vent line shutoff valve (V-8) and associated piping. The right end connects to the tank and the left end connects to the PBU assembly.

1-4. LEADING PARTICULARS.

A summary of leading particulars for the storage tank is listed in Table 1-1.

1-5. RELATED PUBLICATIONS.

This manual is designed to be used with the Operation and Maintenance Manual, T.O. 37C2-8-33-1 and the Illustrated Parts Breakdown Manual, T.O. 37C2-8-33-4.

Table 1-1. Leading Particulars

General Information	
Identification	Liquid Nitrogen Storage Tank, Type TMU-35/E
Manufacturer	Cryenco, Inc., Denver, Colorado
Part Number	110700
National Stock Number	NSN 3655-01-281-5438YD
Capacity:	
Gross Volume	2,200 gallons
Net Volume	2,000 gallons
Weight:	
Empty	8,000 Pounds
Full	25,500 Pounds
Evaporation Rate	Less than 75 lbs. of liquid per 24 hours
Over-All Dimensions	
Length	160.25 inches
Width	90 inches
Height	95.25 inches
Inner Vessel	
Design and Fabrication Criteria	Section VIII of ASME Code.
Type	Cylindrical Vessel, 304 Stainless steel welded construction with torispherical heads.
Operating Pressure (Max.)	55 psig.
Outer Vessel	
Type	Cylindrical Vessel, carbon steel welded construction and torispherical heads.
Insulation	
Type	Multi-layer (incorporating aluminum/reflective radiation barriers, glass paper) and vacuum.
Manual Control Valves	
Type	Bronze-body, globe valve with replaceable seat, Teflon packing and KEL-F disc. Extended stainless steel stem.
Leakage	Not to exceed 2 cubic inches of free air or nitrogen gas per hour per inch of nominal valve size.

Table 1-1. Leading Particulars--Cont.

Filters	
Type	In-line stainless steel wire mesh element fused to filter housing.
Rating	10-micron nominal, 60 microns absolute.
Tank Relief Valve	
Type	Bronze-body cryogenic safety relief valve. Stainless steel spring, special Teflon seat. Meets ASME Boiler & Pressure Vessel Code, Section VIII requirements. 2-inch IPS inlet and outlet. Set at 60 psig.
Rupture Disc Assembly	
Type	Union, with 2-inch inlet and outlet. Rated at 91 psig.
Pressurization (Pressure Buildup) Coil	
Type	Exposed tube heat-exchanger coil.
Line Relief Valves	
Type	Inline type, 75 psig.
Liquid Level Indicator	
Type	0-2200 gallon, differential pressure (single bellows).
Tank Pressure Indicator	
Type	0-100 psig. Bourdon tube type.
Vacuum Indicator	
Type	Thermocouple (FSN 6685-00-877-9593).
Connections	
Fill/Drain Coupling	3-inch male (per USAF Dwg. 8991180).
Service Hose Couplings	1-inch female (per USAF Dwg. 8991172).
Vacuum Seal-Off	1¼-inch, 150 lb. carbon steel flange.
Vapor Vent Discharge	2-inch female, NPT.
Service Hose	
Type and Dimensions	1-inch ID x 10 Feet. Liquid nitrogen transfer (per USAF Dwg. 59C6671-2-10).

SECTION II

SPECIAL TOOLS AND TEST EQUIPMENT

2-1. GENERAL.

Special tools and test equipment required for the repair, overhaul, and testing of the storage tank and its components are listed in Table 2-1 and shown in Figures 2-1 and 2-2. Consumable materials used for the above operations are listed in Table 2-2. Approved equivalent tools and materials can be substituted where appropriate. Related Publications are listed in Table 2-3.

Table 2-1. Special Tools and Test Equipment

Tool/Equipment No.	Fig. No.	Nomenclature	Use and Application
Consolidated Electrodynamics Corporation 24-120A	---	Helium Mass Spectrometer	Leak Checking.
Type KTC-2 (NSN 4310-00-323-8866, P/N 806889	---	Vacuum Pump, electrically driven 220/440 VAC	Evacuation (Pumpdown) operations.
	---	Liquid Oxygen Sampler	Contaminant Testing.
Type GSU-62M	---	Air Purging Unit, 220/440 VAC	Purging Operations.
3655-00-106-6647YD	---	Seal-Off Valve Operator	Evacuation (Pumpdown) operations, vacuum testing.
Part No. 15840 (NSN 6685-00-115-9602YD)	2-1	Vacuum Gage	Check Annular space vacuum
Millipore Cat. No. XX4504700	---	High Pressure Filter Holder	Cleanliness Testing.
Millipore Cat. No. SMWP 04700 04700	---	Filter, Type SM, 5.0	Cleanliness Testing.
NSN 6685-01-117-9913YD P/N 50C-0016-2	2-2	Dual Efficiency Meter	Evaporation Loss Testing.
4-4-1217-21-T,-22-T	---	Globe Valve Seat Wrench	Globe Valve Disassembly.

Table 2-2. Consumable Materials

Material	Specification	National Stock No.
Solvent, Trichlorotrifluoroethane (Freon)	MIL-C-81302	6850-00-681-5688
Leak Detection Compound, Oxygen Systems, Type 1	MIL-C-25567C	6850-00-621-1820
Grease, Stopcock (liquid oxygen compatible)	KEL-F-90	9150-00-745-2760
Grease, Vacuum	DV 6M (MIL-G-27617)	
Primer, Organic Zinc	AF 7545352	
Paint, Polyurethane	MIL-C-83286	
Tape, Antiseize, Tetrafluoroethane, 1/2 inch	MIL-T-27730	8030-00-889-3535
Nitrogen	BB-N-411, Type 1, Grade A	6830-00-285-4769
Brazing Rod or Wire	QQ-B-654A	
Brazing Flux	O-F-499c	
Kit, Compound, Sealing	953-0001 (Varian Assoc.)	8030-00-998-3321

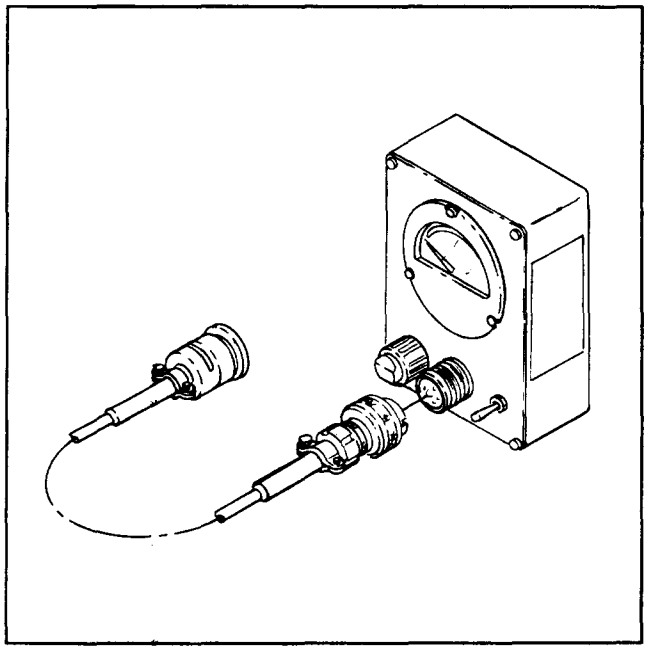


Figure 2-1. Vacuum Gage

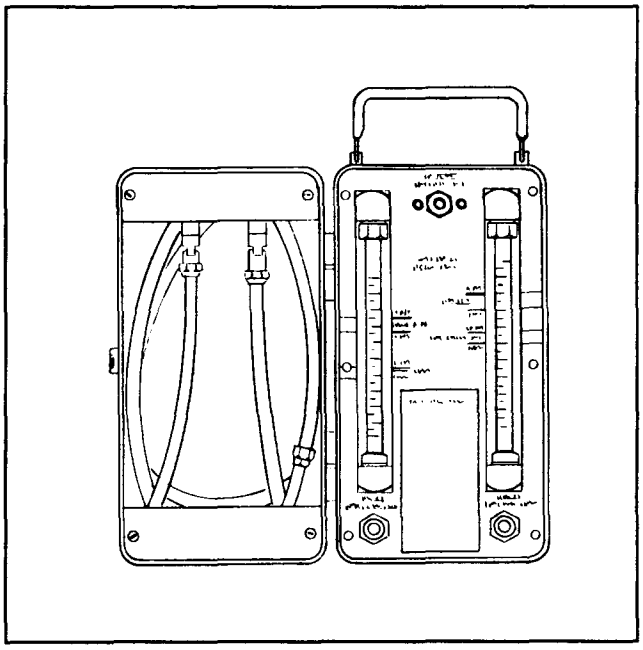


Figure 2-2. Dual Efficiency Meter

Table 2-3. Related Publications

Publication No.	Title
T.O. 00-5-1	AF Technical Order System
T.O. 00-25-107	AFLC Area Support
T.O. 00-25-172	Ground Servicing of Aircraft and Static Grounding/Bonding
T.O. 00-25-223	Integrated Pressure Systems and Components
T.O. 00-25-252	Certification of USAF Aircraft and Missile Welders
T.O. 00-25-229	Valves and Regulators
T.O. 33D2-10-60-1	Cryogenic Sampler
T.O. 34Y5-3-37-1	Operation and Maintenance Instructions Power Driven Rotary Vacuum Pump
T.O. 00-35D-54	USAF Material Deficiency Reporting and Investigating System
T.O. 35-1-3	Painting and Marking of USAF Aerospace Ground Equipment
T.O. 37C2-8-33-1	Liquid Nitrogen Storage Tank, Operation and Maintenance Instructions
T.O. 37C2-8-33-4	Liquid Nitrogen Storage Tank, Illustrated Parts Breakdown
T.O. 37C2-8-1-116WC-1	Inspection Work Cards
T.O. 37C2-8-27-11	Operation, Maintenance and Overhaul Instructions with Illustrated Parts Breakdown for Meter, Dual Efficiency
T.O. 37C11-3-1	Vacuum Gage (Portable), Part No. 15840
T.O. 36G2-3-1	Air Purging Unit, Type GSU-62/M
T.O. 37C11-1-1	Cleaning of Pressure Gages Used
AFOSH-STD-127-66	Occupational Safety General Industrial Operations
AFR-144-1	Fuels Management
MIL-STD-808(USAF)	Finishes, Protective, and Codes for Finishing Schemes for Ground Support Equipment
T.O. 35-1-3	Corrosion Prevention, Painting and Marking of USAF Support Equipment (SE)

SECTION III

DISASSEMBLY

3-1. SCOPE.

This section contains instructions for disassembling the storage tank. These instructions provide for the removal of all components down to the authorized level of repair, and, for the further dismantling of components where parts may be replaced, repaired, cleaned, tested, or inspected.

3-2. PREPARATIONS AND PRECAUTIONS.

Certain general precautions and preparations must be considered prior to disassembly of any assembly, subassembly or component of the storage tank. A review of the following paragraphs is suggested before disassembly is attempted:

a. Only qualified personnel will be authorized to disassemble or repair the storage tank. Safety precautions must be followed. If unsure of safety requirements, consult your Safety Officer.

b. All procedures must be accomplished in a clean, well-ventilated area of sufficient size to facilitate handling operations. An environmentally controlled area is ideal, but may be impractical. Maintenance and repair personnel must take every precaution to assure the maximum cleanliness of all parts.

c. Wear clean, white, lint-free gloves while performing the tasks outlined in this section. Use polyethylene bags to protect all clean parts and to seal all piping outlets until ready for assembly.

d. Disassembly of the storage tank and its components should be limited to that necessary for repair or replacement, or for required cleaning and inspection. Components of the storage tank that are removed solely for access to other components should be tagged and laid aside for subsequent reassembly. If removed parts are in contact with either the product or the vacuum, they must be protected against contamination by polyethylene bags, and stored in a suitable place for subsequent reassembly.

e. Storage tanks need not be purged prior to disassembly or repair if the unit has not been out of service for an extended period (4 months or more), and the integrity of the unit has not been breached. However, if there is any reason to believe that the inner vessel or any of the piping has become contaminated, either through damage, carelessness or long-term storage, the unit must be drained and purged. See Section IV for purging procedures.

f. During disassembly and subsequent handling of components, exercise care to avoid any damage. Use particular care to avoid scratching or otherwise defacing flared-tube mating surfaces and valve seats.

g. The storage tank may be lifted with a common cable and slings, or with a fork lift, using the forklift slots provided in the skid assembly. Refer to Operation and Maintenance Instructions, T.O. 37C2-8-33-1, for further lifting and handling information.

h. Only tools most suited for the particular application may be used in disassembling the unit to prevent damage, distortion and breakage of parts.

i. Subassemblies removed intact (i.e. manifolds, valves, or piping assemblies) shall be supported in a suitable fixture, vise, or type of support during disassembly and subsequent reassembly.

j. Tag all parts for identification during disassembly. This will prevent the confusion of similar parts during reassembly.

k. Riveted, press-fit, and adhesive-attached (e.g. decals, nameplates) parts should not be removed except for replacement.

l. Remove and discard gaskets and preformed packings (O-rings) exposed during disassembly, as necessary. As a general rule, they should be replaced with new components at reassembly.

m. Remove all anti-seize tape from threaded

fittings during disassembly. Remove all particles of the tape and take care that none enter the system.

n. Some repair parts for the storage tank are provided in the form of kits. The Illustrated Parts Breakdown, T.O. 37C2-8-33-4, identifies these parts. Repair and overhaul activities shall replace all parts, regardless of condition, which are removed in the process of disassembly with all like parts furnished in a kit. Therefore, instructions for cleaning, inspecting and reworking such used parts have been omitted. If any parts in the kits must be cleaned, inspected, or tested prior to installation, instructions for performing these requirements are included in this manual. Naturally, all defective parts are to be replaced; but a part unnecessarily removed in the process of disassembly, shall not be removed solely for the purpose of replacement by a corresponding kitted part. Refer to AFLCR 65-42 regarding residue from kits and removed parts in this category.

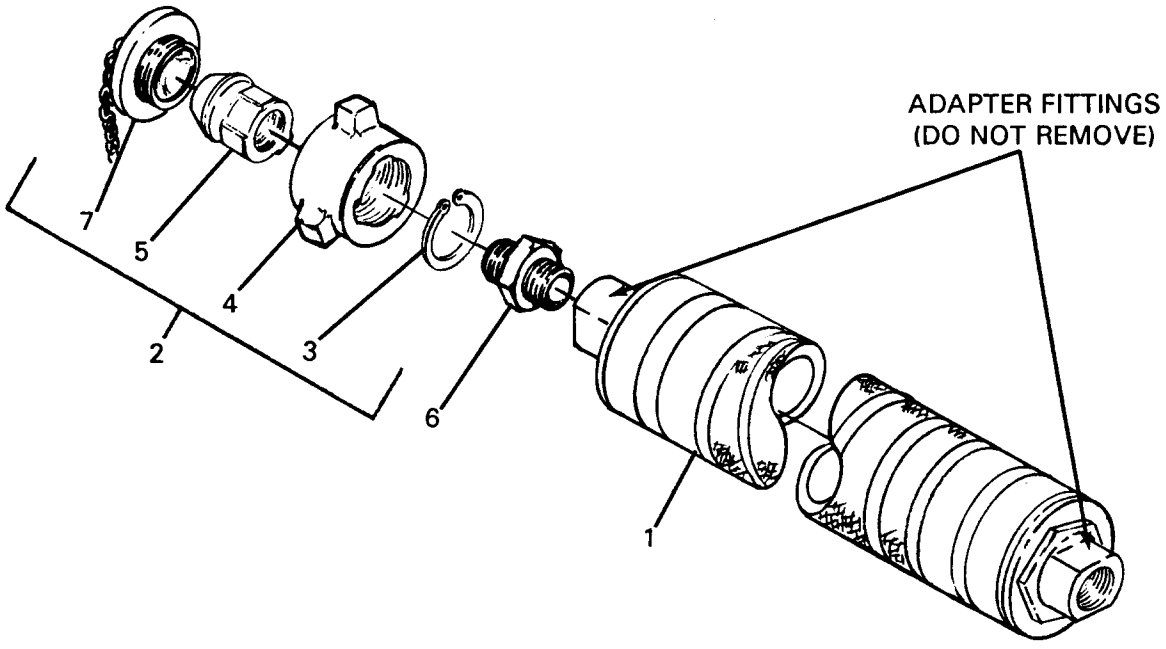
3-3. DISASSEMBLY.

a. Storage tank must be totally drained before disassembly. If the storage tank contains a quantity of product measurable on the liquid level gage, pressure drain it in accordance with the procedures in Operation and Maintenance Instructions, T.O. 37C2-8-33-1.

b. If storage tank contains no measurable product (as indicated by the liquid level gage), make sure that no traces remain in tank. Remove all protective covers from all tank outlets and open the control valves.

c. When all product and gasses have been vented, perform the purging operations outlined in Section IV, as necessary. Refer to Paragraph 3-2, step e, to determine if purging is required.

3-3.1. Disassembly Procedures. Disassembly of the storage tank is generally in the order of the index numbers assigned in Figures 3-1 through 3-9 and as detailed in the following paragraphs. While the



LEGEND

1. Service Hose Assembly
2. Coupling Assembly
3. Retaining Ring
4. Coupling Nut
5. Coupling Cone
6. Nipple, Hex
7. Plug

Figure 3-1. Service Hose Assembly

instructions outline the procedures for complete disassembly, this is not ordinarily desirable, necessary or practical to effect repairs. Disassemble the unit only to the extent required for the removal and replacement of defective parts. The orderly disassembly of the storage tank is as follows:

3-3.1.1. Service Hose Disassembly. (See Figure 3-1). The service hose provides the means by which the liquid product is transferred from the storage tank to the receiving vessel or service vehicle. Remove and disassemble as follows:

a. Lift the hose from the support at the top of the cabinet; then, holding the hose in a vertical position, turn it counter-clockwise until it is free of the service elbow. Cover both ends of the hose, service coupling and female adapter with polyethylene bags, taped in place, to prevent the entry of dust or moisture.

b. Holding the nipple (6) securely with a suitable wrench and gripping the coupling (2) with a spanner-type wrench, turn the coupling counter-clockwise until it is disconnected from the nipple.

c. If desired, further disassemble the coupling (2) by removing the retaining ring (3), and separating the coupling nut (4) and coupling cone (5).

d. Holding the hose adaptor wrench flats with an appropriate wrench, and using a suitable wrench on nipple (6), turn the nipple counter-clockwise until separated from the hose. Do not attempt to remove hose adaptor fittings.

3-3.1.2. Globe Valve Disassembly. (See Figure 3-2). Access to components of the valve bonnet and stem assembly may be achieved by removing the handwheel and uncoupling the bonnet nut and lifting the bonnet and stem away from the valve body.

a. Open valve and remove handwheel nut (1) and remove handwheel (2).

b. Supporting the valve body (16) to prevent twisting, and using a suitable wrench, uncouple bonnet nut (6) from valve body and lift the stem and bonnet assembly away from body and cabinet.

c. Using suitable wrenches, and taking care not to damage components, turn packing nut (3) counter-clockwise until it is free of bonnet (7). Separate packing gland (4) from bonnet.

d. Holding the bonnet (7) stationary, turn the valve stem (14) clockwise until the threaded portion extends beyond the bonnet. The remainder may then be pulled through the bonnet and separated from it. This provides easy access to the packing (5) which may now be extracted using a suitable hooked tool.

e. Holding the disc locknut (13) with an appropriate wrench, carefully disassemble, in sequence, the disc nut (8), disc plate (9), disc insert (10), disc holder (11), horseshoe ring (12) and disc locknut (13) from the stem (14).

f. Using the appropriate special tool, support the valve body (16) to prevent twisting and remove seat (15).

3-3.1.3. Instrument Panel Disassembly. (See Figure 3-3). The instrument panel assembly consists of the liquid level (LL-1), pressure gage (PI-1), pressure control valve (PC-1) and associated piping and components. Remove and disassemble the instrument panel as follows:

a. Loosen tube nuts (4) on tubing connected to the pressure control valve (11), to tee (6), elbow (20) and tee (14).

b. Remove screws and nuts attaching panel (27) to control housing and remove panel (27).

c. Remove cap (1), nut (2), loosen nut (15), and remove union (3).

d. Loosen tube nuts on tubes (5) and remove tubes (5) and tee (6).

e. Remove connectors (7).

f. Remove setscrew (8) and remove wing nut and knob (9). Remove nut (10) and remove pressure control valve (11) from panel (27).

g. Loosen tube nuts on tube (12) and remove tube (12), elbow (13) and tee (14).

h. Remove covers (18).

LEGEND

1. Nut
2. Handwheel
3. Packing Nut
4. Packing Gland
5. Packing
6. Bonnet Nut
7. Bonnet Assembly
8. Disc Nut
9. Disc Plate
10. Disc Insert
11. Disc Holder
12. Horseshoe Ring
13. Disc Locknut
14. Stem Assembly
15. Seat
16. Body

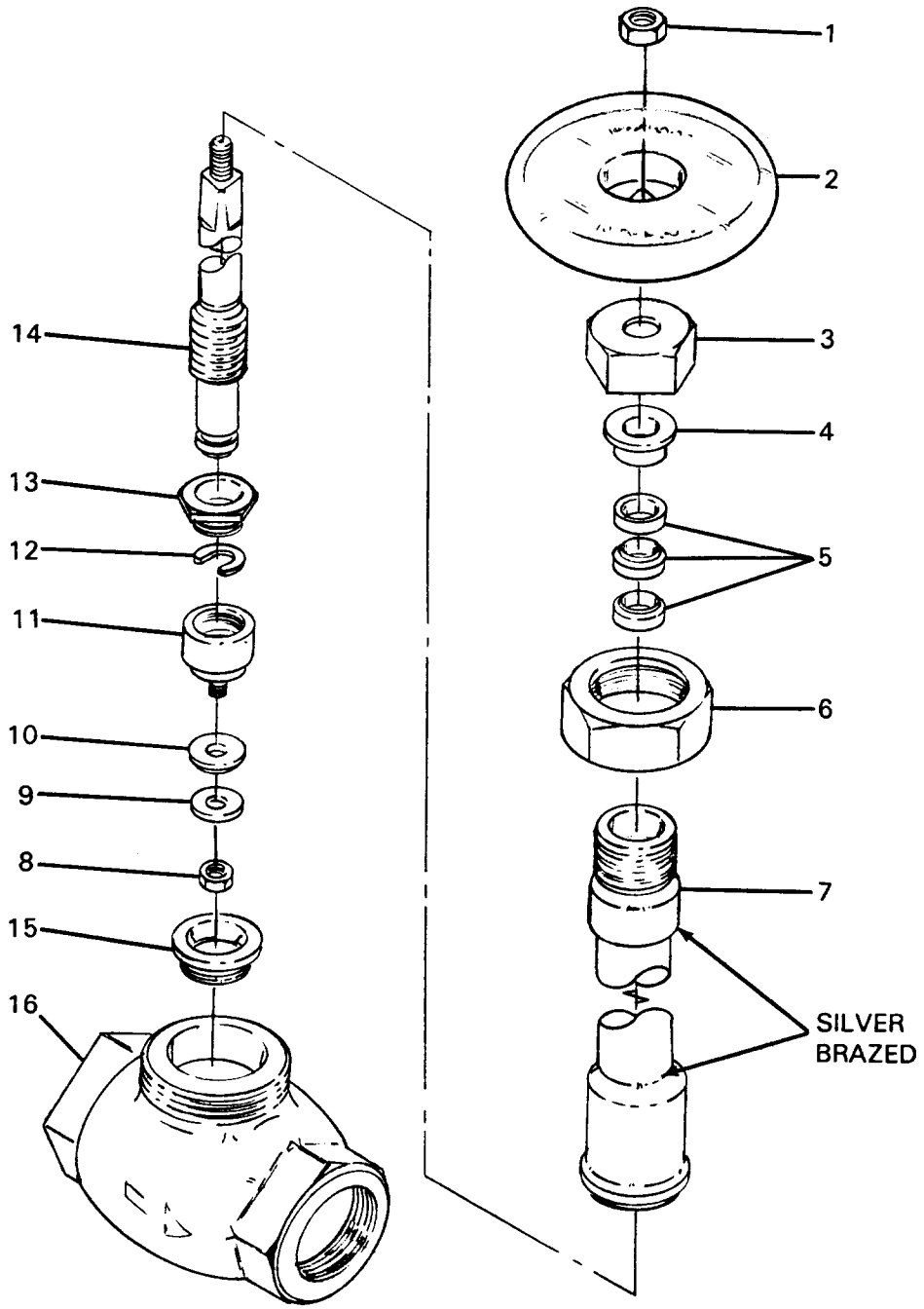


Figure 3-2. Globe Valve

i. Remove nuts (15), washers (16), screws (17) and liquid level gage (19) from panel (27). Remove elbow (20) from gage (19).

j. Remove nuts (21), washers (22), screws (23) and remove pressure gage (24) from panel (27).

k. Remove rivets (26) and identification tags (25) from panel (27).

3-3.1.4 Vent Piping Disassembly (See Figure 3-4). The vent piping assembly consists of a relief valve (RV-3), rupture disc (SD-1), globe valve (V-8) and associated piping components. Relief valve (3) is not field repairable and should be replaced with a new valve if found to be defective. If valve (5) is found to be defective, see paragraph 3-3.1.2 for disassembly procedures. Remove and disassemble the vent piping assembly as follows:

a. Remove top cover of control cabinet.

b. Loosen tube nut and remove tube from connector (14).

c. Remove elbow (13) and stem and bonnet assemblies from (V-8) (V-6) (V-5) (V-4) and (V-9) per paragraph 3-3.1.2., steps a and b.

d. Unscrew and disconnect coupling at each end of vent piping subassembly (7).

e. Remove u-bolts (10) by removing nuts (8), washers (9) and plate (11). The unit now may be pulled through side of cabinet and up and away from cabinet.

f. Remove elbow (1), rupture disc unit (2), relief valve (3) and elbow (4).

g. Remove valve body (5) and nipple (6) from piping subassembly.

3-3.1.5 Fill/Drain Line Disassembly (See Figure 3-5). The fill/drain line assembly consists of two globe valves and associated piping components. If either valve is found to be defective, see paragraph 3-3.1.2 for disassembly. The fill/drain assembly cannot be removed as an assembly. Disassemble the assembly as follows:

a. Remove stem and bonnet assembly from valves (2,5) as per paragraph 3-3.1.2., steps a and b. Disconnect PBU segment (1) from PBU unit.

b. Disconnect fill/drain line filter from nipple (3).

c. Remove PBU segment (1) from valve (2).

d. Remove valve (2) from fill/drain segment (6).

e. Remove nipple (3) from elbow (4) and elbow (4) from valve (5).

f. Remove valve (5) from fill/drain segment (6).

3-3.1.6. Cabinet Disassembly (See Figure 3-6). The cabinet assembly is attached by bolts, washers and nut at the bottom and sides of the cabinet. Although it is not practical to remove the cabinet assembly for most repairs, it may be removed and disassembled as follows:

a. Remove vent piping assembly as per paragraph 3-3.1.4.

b. Remove instrumentation panel as per paragraph 3-3.1.3.

c. Remove stem and bonnets from valves (2,5) as per paragraph 3-3.1.2., steps a and b.

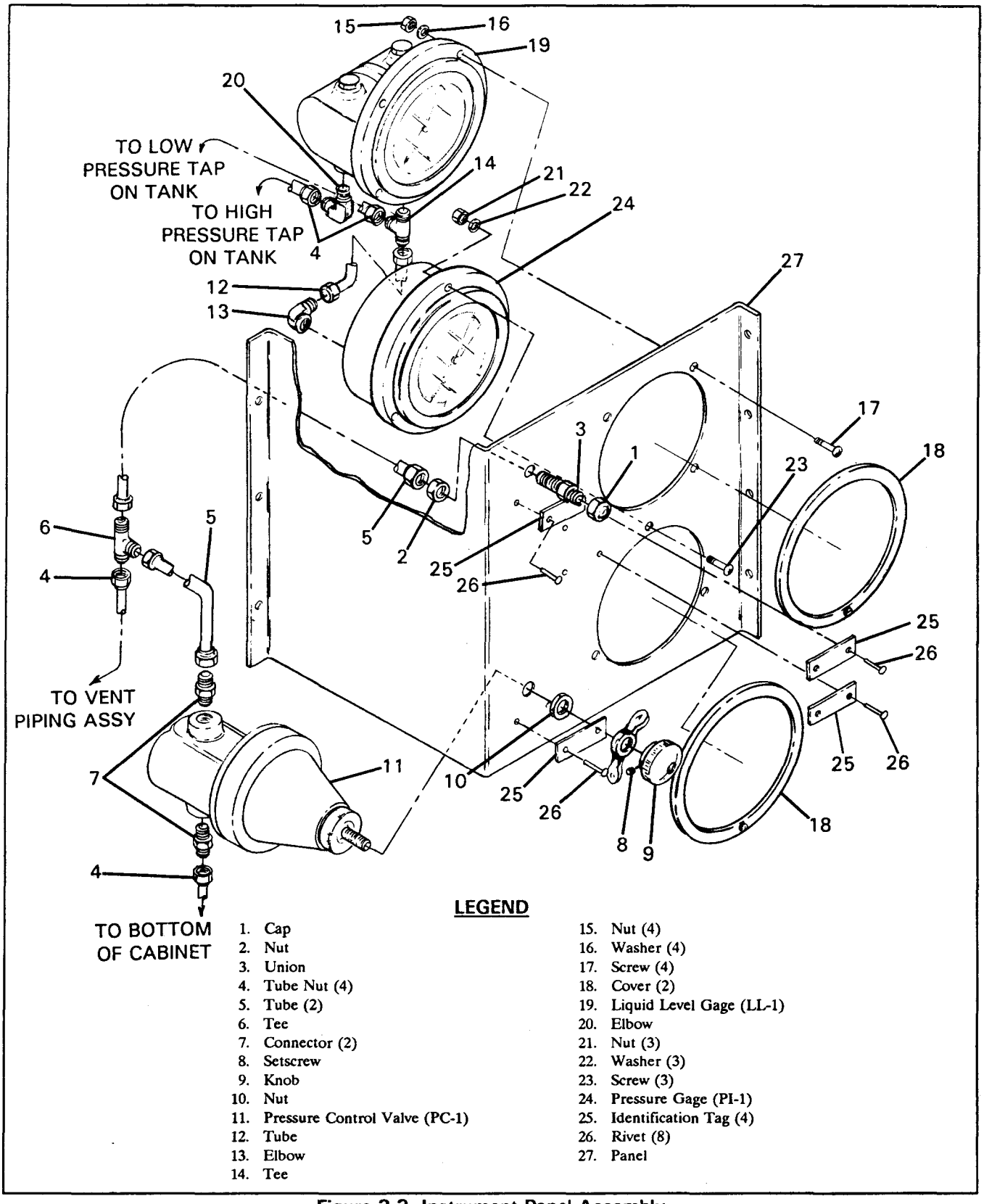
d. Remove all instrument lines (4) by removing nuts (5), washers (6), screws (7) from tube clamps (8) and disconnecting tubes at each end (Refer to figure 3-7, detail D).

e. Remove u-bolts (20) by removing nuts (19) and remove items (16, 17, and 18) as on assembly. Ensure adequate support as provided at tank connection during removal (Refer to figure 3-7, detail E).

f. Remove door (15), hinge (18) and bracket (21) by removing nuts (19,22), screws (20,24) and lockwashers (23).

g. The cabinet may now be removed by tilting forward and lifting, using care to avoid damaging the thermocouple and full trycock valve connections.

h. Remove door keepers (9) from door by



LEGEND

1. Cap
2. Nut
3. Union
4. Tube Nut (4)
5. Tube (2)
6. Tee
7. Connector (2)
8. Setscrew
9. Knob
10. Nut
11. Pressure Control Valve (PC-1)
12. Tube
13. Elbow
14. Tee
15. Nut (4)
16. Washer (4)
17. Screw (4)
18. Cover (2)
19. Liquid Level Gage (LL-1)
20. Elbow
21. Nut (3)
22. Washer (3)
23. Screw (3)
24. Pressure Gage (PI-1)
25. Identification Tag (4)
26. Rivet (8)
27. Panel

Figure 3-3. Instrument Panel Assembly

LEGEND

1. Elbow
2. Rupture Disc Unit (SD-1)
3. Relief Valve (RV-3)
4. Elbow
5. Globe Valve (V-8)
6. Nipple
7. Vent Piping Subassembly
8. Nut (12)
9. Washer (4)
10. U-bolt (2)
11. Plate (2)
12. Nipple
13. Elbow
14. Connector

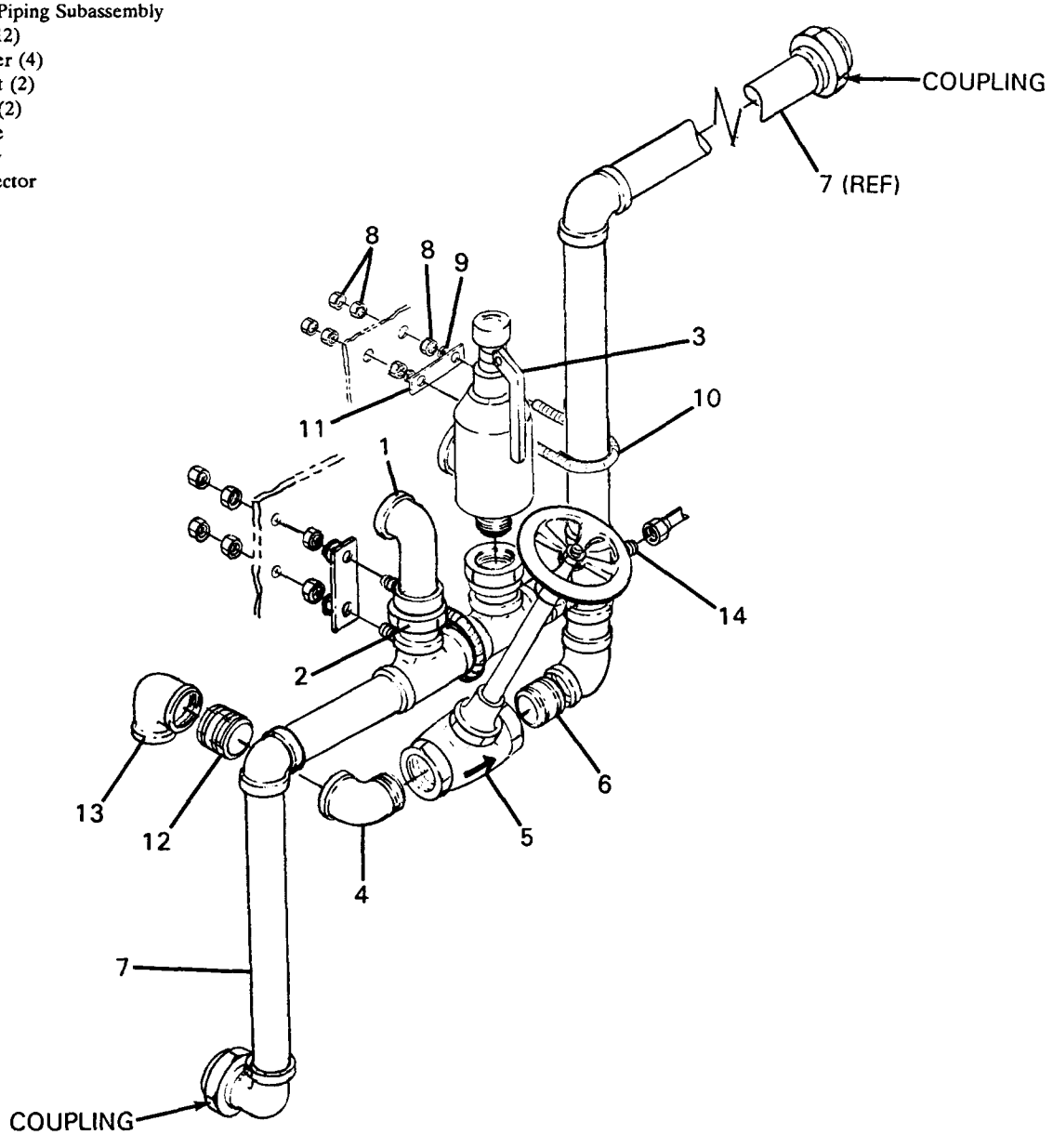


Figure 3-4. Vent Piping Assembly

removing nuts (10) and screws (11).

i. Remove door latches (12) by removing nuts (13) and screws (14).

j. Remove door latches (25) by removing nuts (26) and screws (27).

k. Plates (28,29,30) may be removed by removing rivets (31) attaching them to door (15).

PBU out from the rear of tank.

b. Remove tubes (4) by removing nuts (5), washers (6), screws (7) from tube clamps (8) and disconnecting tubes at each end.

c. Remove and disassemble the coupling assembly (9) by removing screw (49) and nut (51), and disassemble plug (12), retaining ring (13), nut (14), and coupling cone (15).

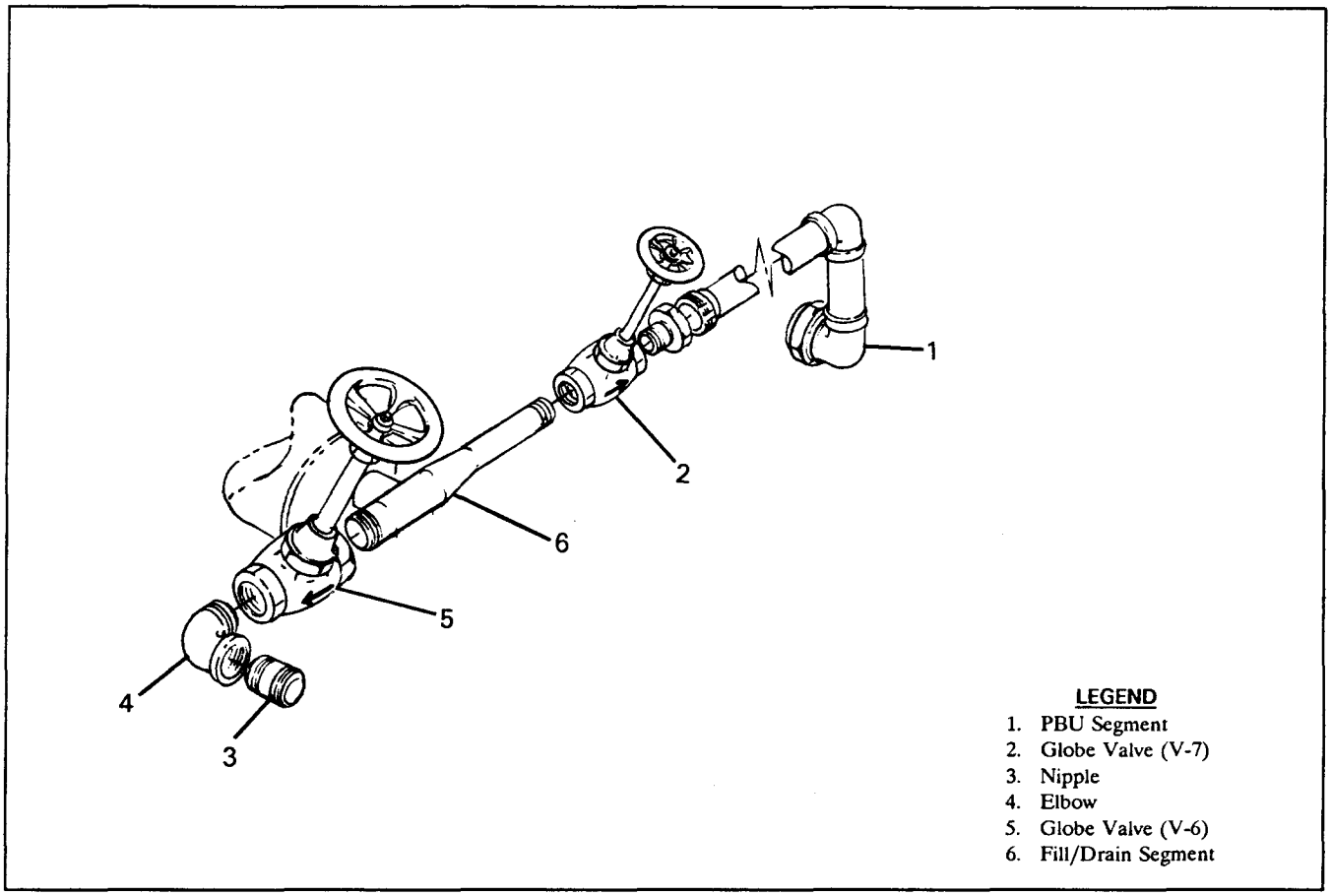


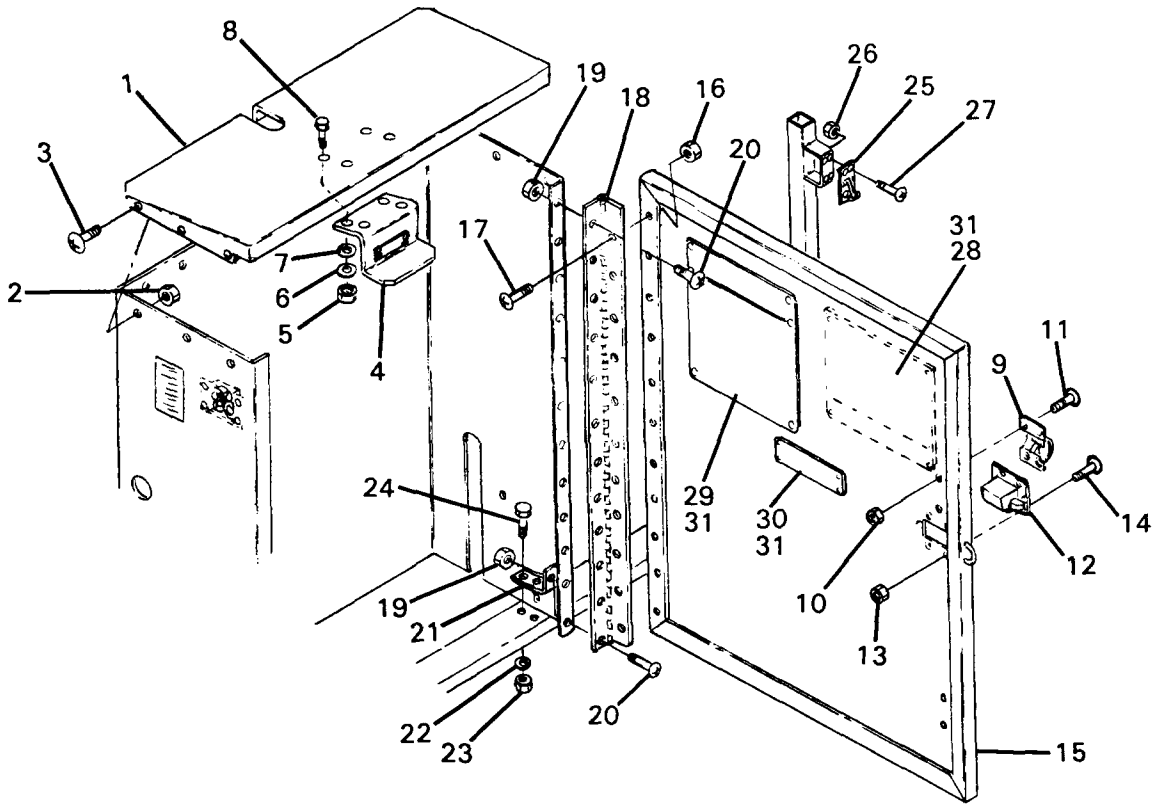
Figure 3-5. Fill/Drain Line Assembly

3-3.1.7 Piping Disassembly (See Figure 3-7). The piping consists of filter assemblies (F-1, F-2), relief valves (RV-1, RV-2), valves (V-4, V-5, V-9), PBU assembly and associated brackets, hardware and piping components. Remove components of the piping as follows:

a. Remove PBU assembly (1) by disconnecting vent piping assembly and fill/drain assembly, removing nuts (2), brackets (3) and pulling

d. Before removing globe valve V-9 (16), the stem and bonnet assmebly must be removed as per paragraph 3-3.1.2., steps a and b. Then disconnect tube from elbow (17) and remove elbow. Remove valve body (16) from pipe nipple (18).

e. Remove pipe nipple (18) by removing nuts (19), u-bolt (20) and unscrewing and removing pipe nipple (18) with adequate support at tank connection.



LEGEND

1. Cabinet top
2. Nut (11)
3. Screw (11)
4. Bracket
5. Nut (4)
6. Flat washer (4)
7. Lockwasher (4)
8. Screw (4)
9. Door Keeper (2)
10. Nut (8)
11. Screw (8)
12. Door Latch
13. Nut (4)
14. Screw (4)
15. Door
16. Nut (11)
17. Screw (11)
18. Door Hinge
19. Nut (12)
20. Screw (12)
21. Bracket
22. Nut (2)
23. Lockwasher (2)
24. Screw (2)
25. Door Latch (2)
26. Nut (8)
27. Screw (8)
28. Lifting Plate
29. Operation Plate
30. Insulation Plate
31. Rivet

Figure 3-6. Cabinet Assembly

f. Remove coupling assembly and bushing (24). Disassemble coupling assembly by removing coupling seat (23), gasket (22) and cap (21).

g. Remove elbow (27) and nipple (28) from globe valve V-5 (29).

h. Remove stem and bonnet assembly from valve (V-5) (29) per paragraph 3-3.1.2., steps a and b, and remove valve body.

i. Remove relief valve RV-2 (30), coupling (31), and elbow (54) from nipple (32). Unscrew compression nut on nipple (32) and remove elbow (33) and nipple (32).

j. Remove u-bolt (34) from around filter (35) by removing nuts (36) and washers (37).

k. Supporting the pipe nipple with a suitable wrench to prevent torsion, turn filter (35) counter-clockwise until it is free.

l. Lift the service hose from the support bracket. Then, holding the hose in a vertical position, turn it counter-clockwise until it is free of the service elbow (41). Cap the exposed hose end with polyethylene bags and tape, and move it away from the area.

m. Before removing globe valve V-4 (38), the stem and bonnet assembly must be removed as per paragraph 3-3.1.2. Then remove elbow (39) and valve (38) from elbow (40).

n. Remove elbow (41), relief valve RV-1 (42), coupling (43) and elbow (54) from nipple (44). Unscrew compression nut on nipple (44) and remove elbow (40).

o. Remove u-bolt (45) from around filter (48) by removing nuts (46) and washers (47).

p. Supporting the pipe nipple (44) with a suitable wrench to prevent torsion, turn filter (48) counter-clockwise until it is free.

3-3.1.8. Thermocouple and Vacuum Gage Valve Removal and Disassembly. (See Figure 3-8). The thermocouple and vacuum gage valve are not normally removed or disassembled. Instructions are included only to offer a means of repair in case of damage.

a. The vacuum gage (thermocouple isolation) valve (V-12) must not be removed from the storage tank unless the annular space has been filled with dry nitrogen gas (See Section V). Replacement of the valve should only be considered in the case of failure to operate properly or leakage.

b. With the vacuum gage (thermocouple isolation) valve (2) closed, unscrew the thermocouple gauge tube (1) from the vacuum gage valve (2).

c. Using a suitable wrench, turn the valve body counter-clockwise until it is free of the tank fitting. Remove any traces of old vacuum sealing compound to prevent any particle of it from entering the tank when it is evacuated. Make sure that the tank fitting is covered at all times when the valve is removed to prevent the entry of dust or moisture.

3-3.1.9. Seal off Valve Disassembly. (See Figure 3-9). The vacuum seal-off valve (SD-2) is not normally disassembled as matter of routine maintenance. Instructions are offered only to offer a means of removal and replacement of parts following valve failure. Do not attempt repairs until the annular space has been filled with dry nitrogen gas (Refer to Section V).

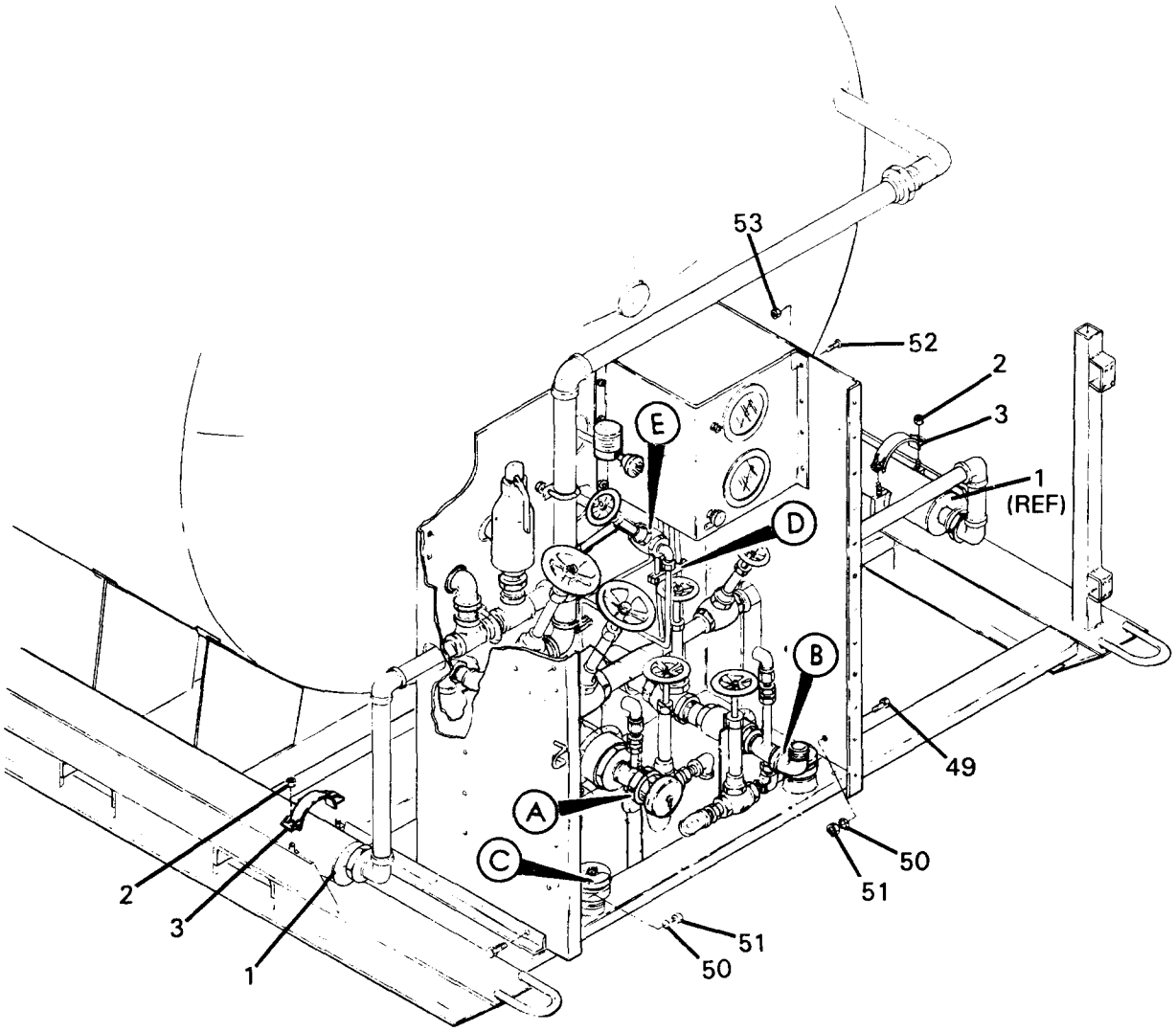
a. Pull the protective cap (1) from the valve body (2).

b. Following the procedures outlined in Section V (Breaking the Annulus Vacuum), allow the annular space to be filled with gaseous nitrogen to atmospheric pressure.

c. Using the seal-off valve operator, extract the plug (4) from the valve body. Detaching the tool from the body, press the tool shaft down to expose the plug, and unscrew the plug from the shaft. The vacuum sealing o-ring (3) can be removed and replaced.

d. The valve body (2) is welded to the outer jacket of the storage tank. If the body is damaged, suspect that the annular space is contaminated. Field repair of the valve body is not recommended.

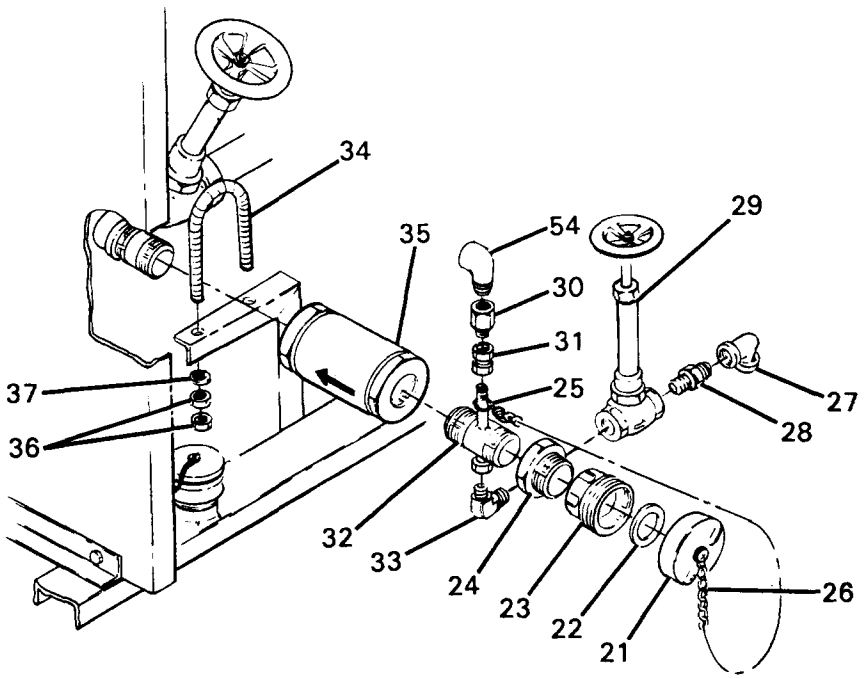
3-3.1.10. Vacuum Line Shut-off Valve Disassembly. (See Figure 3-10). The vacuum line shut-off valve



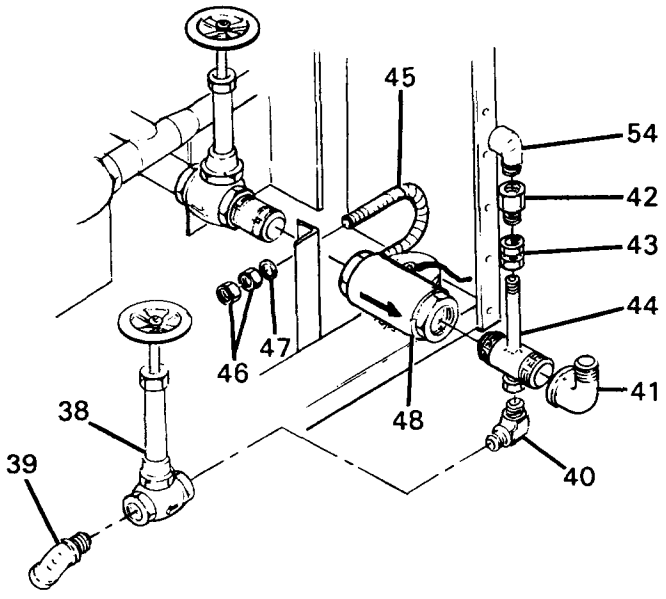
LEGEND

1. PBU Assembly
2. Nut (8)
3. Bracket (4)
4. Tube (4)
5. Nut (6)
6. Washer (6)
7. Screw (6)
8. Clamp (3)
9. Coupling Assembly
10. "S"-hook
11. Chain
12. Plug
13. Retaining Ring
14. Nut
15. Coupling Cone
16. Globe Valve (V-9)
17. Elbow
18. Nipple
19. Nut (4)
20. U-bolt
21. Dust Cap
22. Gasket
23. Coupling Seat
24. Bushing
25. "S"-hook
26. Chain
27. Elbow
28. Nipple
29. Globe Valve (V-5)
30. Relief Valve (RV-2)
31. Coupling
32. Nipple
33. Elbow
34. U-bolt
35. Filter (F-2)
36. Nut (4)
37. Washer (2)
38. Globe Valve (V-4)
39. Elbow
40. Elbow
41. Elbow
42. Relief Valve (RV-1)
43. Coupling
44. Nipple
45. U-bolt
46. Nut (4)
47. Washer (2)
48. Filter (F-1)
49. Screw (7)
50. Washer (7)
51. Nut (7)
52. Screw (7)
53. Nut (7)
54. Elbow (2)

Figure 3-7. Piping Assembly, 2000-Gallon



(FILL/DRAIN FILTER)
DETAIL "A"



(SERVICE FILTER)
DETAIL "B"

Figure 3-7. Piping Assembly, 2000-Gallon (CONT)

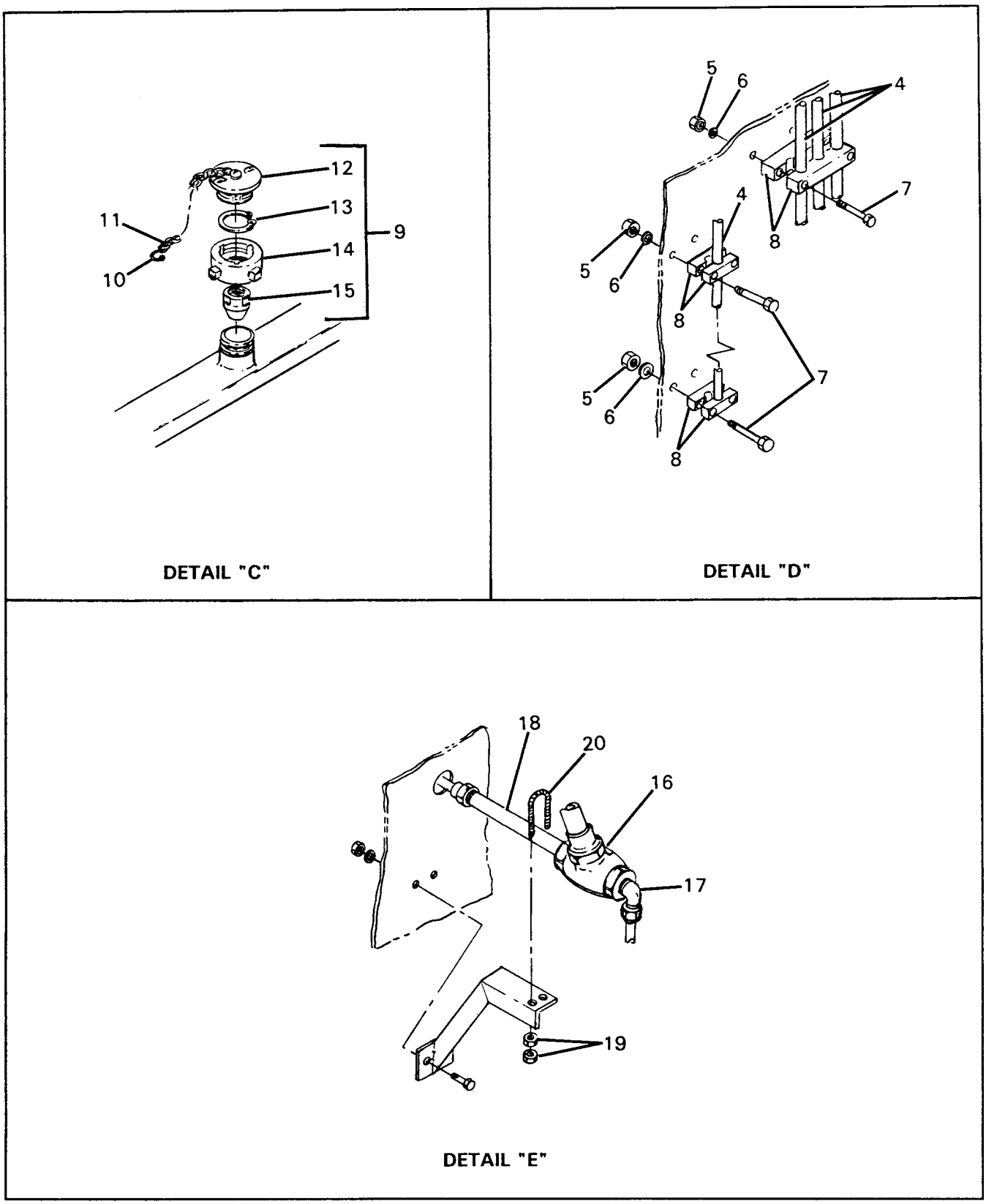


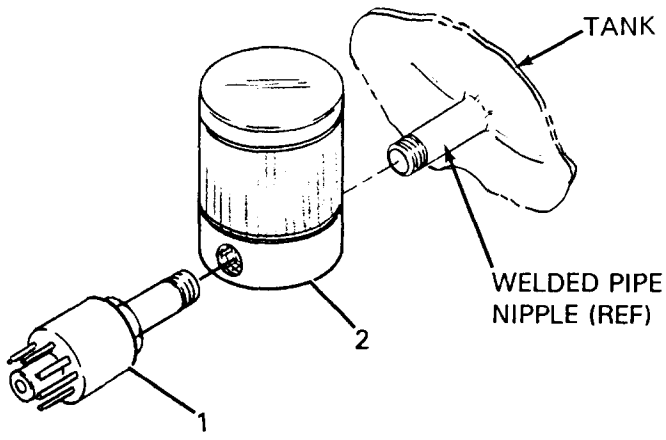
Figure 3-7. Piping Assembly, 2000-Gallon (CONT)

(V-10) is not normally disassembled as a matter of routine maintenance. Instructions are offered only to offer a means of removal and replacement of parts following valve failure. Do not attempt repairs until the annular space has been filled with dry nitrogen gas (Refer to Section V).

a. Remove vacuum flange (4) by removing nuts (5), washers (6) and bolts (7). Remove o-ring (3).

b. Unscrew flange weldment (2).

c. Unscrew vacuum valve (1).



LEGEND

1. Thermocouple Gage Tube
2. Vacuum Gage (Thermocouple Isolation) Valve

Figure 3-8. Thermocouple and Vacuum Gage Valve Assembly

LEGEND

1. Cap
2. Body (Welded to Tank)
3. O-Ring
4. Plug

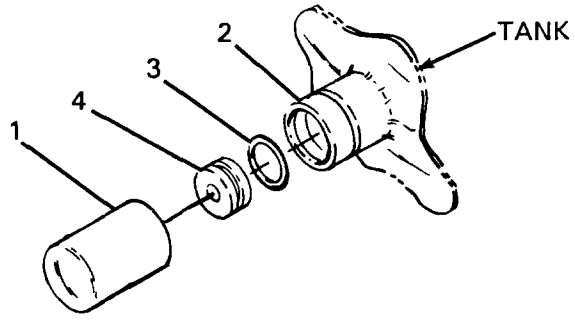


Figure 3-9. Seal-off (Vacuum Pump-down) Valve Assembly

LEGEND
1. Vacuum Valve (V-10)
2. Flange Weldment
3. O-Ring
4. Vacuum Flange
5. Nut (4)
6. Washer (4)
7. Bolt (4)

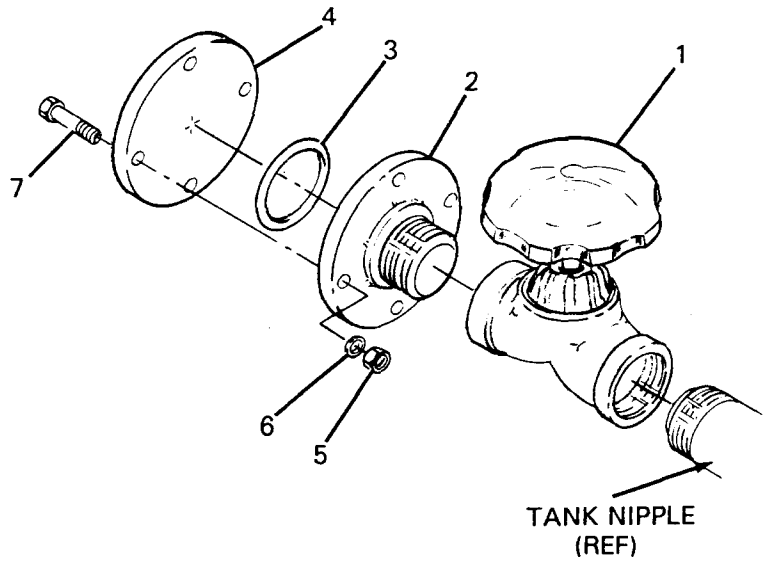


Figure 3-10. Vacuum Line Shut-off Valve Assembly

SECTION IV

CLEANING

4-1. SCOPE.

This section contains special procedural instructions for the cleaning of the storage tank, its subassemblies and components. Procedures are presented for parts as they were removed following the instructions in Section III.

4-2. PRECAUTIONS.

Cleanliness and handling procedures shall be in accordance with those outlined in Section III, Paragraph 3-2. Personnel shall use gloves and face shields, as necessary, when using solvents. Components which will come in contact with liquid product shall be plugged and bagged after cleaning, and shall remain so until reinstalled.

CAUTION

Never use shop compressed air to dry cleaned parts, hose assemblies or connecting fittings. Always use clean, dry, water-pumped gaseous nitrogen, Type BB N 411, for purging and drying.

a. Clean the external surfaces of the storage tank and exposed surfaces inside the control housing with a mild detergent and warm water. Wipe dry with a clean, lint-free cloth. Do not use extremely hot water or steam.

b. Clean parts with clean liquid trichlorotrifluoroethane (freon). Ultrasonic cleaning with approved solvents is also acceptable, as applicable. Dry cleaned parts by purging with dry, water-pumped gaseous nitrogen, Type BB N 411. After cleaning and drying, inspect parts under ultraviolet light (Refer to Section VII). Any evidence of florescence will require recleaning and repetition of the ultraviolet examination.

CAUTION

Allow only a slight flow of gas when drying instruments. Excessive flow will damage instrument sensing elements

c. Filter Cleaning. To remove hydrocarbon and/or particulate contamination, immerse filter in trichlorotrifluoroethane. With unused trichlorotrifluoroethane back flush filter to remove all contamination. Flush filter with demineralized water and blow dry with nitrogen gas, Type BB-N-411. Perform odor test and check for contamination using ultraviolet light. To remove large particulate contamination, tap filter on the inlet port side with sufficient force to remove particles. Use a flat surface and ensure to not damage filter body and repeat filter cleaning until particle contamination is removed. If filter remains clogged after cleaning, it can be discarded.

4-3. PURGING.

Purging is the process of forcing heated air or nitrogen through the drained storage tank, causing residual product and any contaminants which have entered the tank to be converted to a gaseous state and be expelled. Contaminants, present in the product, are normally gasses in the air and reduced to a solidified state as the product is prepared. These contaminants tend to settle in the tank sump, so that concentration increases with tank use. When the concentration reaches an undesirable level, as determined by laboratory or odor tests, the storage tank must be drained and purged.

4-3.1. Frequency of Purging. The storage tank will not be purged on a regular basis. However, sampling is performed at regular intervals as prescribed by T.O. 37C2-8-1-116WC, Periodic Inspection Work Cards. The tank shall be drained and purged whenever the impurities exceed the Use Limits established in T.O. 42B6-1-1. This specifies that once every 90 days, a sample of liquid product shall be sent to a designated laboratory to be tested. Analysis of the results of this test shall be used by the Base Fuels Officer to determine if purging is required.

4-3.2. Procedures. Purging procedures will be accomplished according to the following steps:

a. Portable tanks used to receive contaminated product must also be purged to ensure complete disposal.

b. Ensure storage tank has been drained prior to purging. If not, reference draining procedures in T.O. 37C2-8-33-1.

c. Open vapor vent line shut-off valve (V-8), all other valves are closed.

d. Ensure tank plumbing and filters are at ambient temperature before removal of any components.

e. Remove filters and disconnect tubing to pressure gauge and liquid level gauge, if applicable.

NOTE

The GSU-62/M purging unit or equivalent is required to purge tanks.

f. Position GSU-62/M purging unit next to tank vapor vent line shut-off valve (V-8). Connect purging unit to source of 220/440 volt, 3-phase, 60 cycle AC power outlet.

g. Connect necessary purge unit adapter to tank vent line.

h. Connect purge unit discharge hose to tank vent line, and attach temperature gauge to fill line outlet.

i. Open fill/drain valve (V-6).

CAUTION

Do not allow the temperature of the air exiting the tank to rise above 220°F to prevent possible damage to the tank.

j. Start and operate purging unit following instructions given in T.O. 36G2-3-1. Continue to operate unit and monitor temperature gauge at fill line outlet, until the temperature of 220°F is attained. The temperature of 220°F can be maintained at the outlet by cycling the purge unit heater switch off and on as necessary.

k. All metal tubing and valves on tank will become hot, contact with hot plumbing will result in burns.

l. Alternately open and close all other valves to assure hot air flows through all plumbing and lines.

m. Continue to purge with fill line outlet temperature of 220°F for not less than two hours.

n. When purging time is completed, turn off purge unit heater switch. Continue air flow into inner tank until fill line outlet temperature gauge has cooled to 150°F. This will prevent cooling gases from later causing a vacuum to occur in the inner tank and drawing in atmospheric air and moisture into the inner tank if a valve is opened.

o. Close all valves, turn off and disconnect purge unit service hose and adapters from tank and reposition purge unit away from the area.

p. Reconnect all tubing to instruments and install cleaned filters.

q. Service the tank with product in accordance with T.O. 37C2-8-33-1. Service pressure shall not exceed 10 psig to minimize thermal shock to the inner shell.

SECTION V

INSPECTION, REPAIR AND REPLACEMENT

5-1. SCOPE.

This section presents the necessary instructions for the inspection and replacement of components of the storage tank. In addition to the normally accepted mechanical procedures for repair and replacement, this section also contains directions for breaking the vacuum and the evacuation of the annular space between the inner and outer vessels, leak detection, and the painting of the tank exterior.

5-2. SPECIAL TOOLS AND TEST EQUIPMENT.

The special tools and test equipment required for the performance of the tasks and procedures described in this section are listed in Table 2-1.

5-3. SPECIAL MATERIALS.

The special materials required to perform the procedures in this section are listed in Table 2-2.

5-4. INSPECTION.

Periodic inspections are performed in accordance with T.O. 37C2-8-1-116WC-1, Periodic Inspection Work Cards. However, operating and maintenance personnel must be aware of discrepancies, and the performance of an informal inspection on a monthly basis is highly recommended. During general inspections, check the following:

a. Check the control housing and panels for dents, missing screws, rivets, and washers. Pay particular attention to scraped and missing paint, and other damage.

b. Check the indicating instruments for cracked or broken glass, bent or damaged pointers, loose or damaged couplings or mountings, and moisture in gages.

c. Check all valves for general condition, smooth and positive action. Do not check the vacuum indicator (thermocouple isolation) valve (V-12). Any frosting on a valve or piping is an indication of a possible leak.

d. Check all tubing for looseness, bending, dents or other damage.

e. Check all tank markings and decals for legibility, scratches, looseness, and damage. Damaged decals must be replaced.

f. Check exterior of the storage tank for chipped paint, dents and deformation. Pay particular attention to areas around the forklift tubes and the hoisting and tiedown rings.

g. Check the service hose and its flexible windings for excessive wear. Inspect fittings for thread wear and physical damage.

h. Inspect the fill/drain coupling assembly for damaged or missing coupling cap, gasket, or safety chain. Pay particular attention to coupling seat threads, inspecting for possible damage.

i. Check the overboard vent line, making sure that there are no obstructions (plugs, caps, external blockage) if there is any product in the tank. A polyethylene bag or tape is permitted to exclude dust and moisture, if the tank is in dry storage.

j. Check the general condition of all assemblies, inspecting for loose or missing hardware. Make sure that all flange bolts and fittings are tight.

k. Inspect for general cleanliness. If there is any doubt about hydrocarbon contamination around fittings, or evidence of corrosion products, metal chips, grease, paint, preservatives or any other foreign matter around any area which could be contacted by the product, conduct an ultra-violet light cleanliness test (para. 5-6). Evidence of contamination or foreign matter will indicate that cleaning is required (See Section IV), followed by a repetition of this test.

5-5. PERIODIC INSPECTION.

Complete periodic inspections are performed in accordance with, and at the intervals indicated by T.O. 37C2-8-1-116WC, Periodic Inspection Work Cards.

5-6. CLEANLINESS INSPECTION.

Cleanliness must become an established habit for all personnel associated with the operation and maintenance of the storage tank. The exterior and interior of the unit must meet established criteria for cleanliness which are designed to protect the tank itself, the equipment it services, and the personnel who operate and maintain it. Any discrepancies must be noted and corrected at once. Inspections are as follows:

5-6.1. Exterior Inspection. Make sure that the tank exterior is free of contamination by performing the following steps:

a. Visually inspect for evidence of oils, greases, metal chips and scaling.

b. Using ultraviolet light, check ports, couplings, vapor vent, around service and fill piping, and all of the surrounding areas for evidence of hydrocarbons. Clean any fluorescent areas and remove any fluorescent particles.

5-6.2. Interior Inspection. Perform interior cleanliness inspections only after major overhauls, when contamination is suspected, and before a storage tank is placed in service after long term dry storage. Do not perform the interior cleanliness test unnecessarily, as it involves filling the tank 90% full of liquid nitrogen. Conduct the test as follows:

a. Fill the storage tank to 90% of its design capacity with pre-filtered liquid nitrogen. Accomplish filling through both the fill/drain coupling and service line (hose or elbow).

b. Allow the storage tank to stabilize, undisturbed, for a minimum of two (2) hours.

c. Obtain a Millipore membrane filter (See Table 2-1), weight it, record the weight; and, then place the filter in a Millipore filter holder (See Table 2-1).

d. Remove the protective cap from the drain line, attach filter holder in its place.

e. Using a suitable dewar to receive the liquid nitrogen discharged through the filter holder, open the drain valve (V-6), and allow at least one (1) liter of product to pass through the line and filter.

f. Detach the filter holder and remove the filter element. Dry the filter thoroughly, and examine it for particulate matter and total solids by weighing and visual examination with a calibrated loupe.

(1) No total solid with a dimension greater than 1000 microns will be allowed.

(2) No fibrous particle with a length greater than 6000 microns will be allowed.

(3) No more than 25 milligrams of both solid and fibrous particles will be allowed.

g. If the total material, solid and fibrous, exceeds the above specified requirements, the remaining liquid will be discharged through drain line and the storage tank flushed with liquid nitrogen until the total amounts of foreign material fall within the above outlined criteria.

5-7. REPAIR AND REPLACEMENT.

Most repairs consist of removal and replacement of worn or damaged parts, as determined by visual inspection. Special instructions are presented in the following paragraphs for individual components. Some inspection notes are included with the instructions to clarify the need or facilitate the replacement procedures. Replace all items determined by inspection to be unserviceable. In general, these rules may be followed:

5-7.1. Threaded Components. If threads are nicked, but not deformed, they may be re-threaded, using suitable taps and dies. Small nicks may be chased with a small file.

5-7.2. Nuts. File deformed or nicked wrench flats to proper contours if the nut itself is not deformed.

5-7.3. Corrosion. Remove corrosion by sanding lightly with a light grade of sandpaper or emery cloth.

5-7.4. Gaskets, Preformed Packings (O-Rings). Replace all damaged and worn gaskets and

preformed packings exposed during disassembly. Certain packings, as noted during disassembly and assembly procedures, must be replaced on reassembly.

5-7.5. Fasteners. Replace nuts, nutplates, machine screws, bolts and other threaded fasteners if threads and wrench flats are not repairable. Replace missing or damaged rivets.

5-7.6. Flared Tubes and Flared Tube Fittings. Flared tube assemblies, tubes and fittings should be replaced only if repair is impossible. Be sure to inspect flared surfaces for cracks and deformation; check compression nuts and sleeves.

NOTE

Scratched flared-tube surfaces and stainless-steel fitting surfaces may often be repaired by sanding lightly with a fine abrasive material.

5-7.7. Labels, Decals and Nameplates. Labels, decals and nameplates which have become illegible or partially defaced must be replaced. Check nameplate attachments, replace loose or deformed rivets.

5-7.8. Globe Valves. The service line shut-off valve (V-3), service line drain valve (V-4), fill/drain line drain valve (V-5), fill/drain line shut-off valve (V-6), pressure buildup control valve (V-7), vapor vent line shut-off valve (V-8) and fill trycock valve (V-9) should be inspected for worn parts, deformed packings, scratched or nicked valve seats or discs.

a. Repair of these valves should be limited to the replacement of worn or damaged parts. Internal leakage through a valve is usually the result of a faulty sealing disc or damaged seat ring. External leakage, at the top of a valve bonnet, is usually the result of a damaged or worn packing or loose packing nut.

b. If the valve leaks externally, through the valve stem packing, first try to tighten the packing nut. If this fails to stop the leak, replace the packing. Check the valve stem areas in contact with the packing rings. If it is pitted or worn, replace it.

c. Kits are available (See Illustrated Parts Breakdown, T.O. 37C-8-33-4) to replace the disc and seat assemblies for globe valves.

5-7.9. Instrumentation Valves. The vacuum line shut-off valve (V-10) and the vacuum gage (thermocouple isolation) valve (V-12) are more practically replaced than repaired. Dispose of the damaged valves through the usual channels. Do not operate, remove or attempt to repair the vacuum indicator (thermocouple isolation) valve (V-12) during routine inspections. It should be opened only during vacuum efficiency tests. If it is determined that the valve is defective, it should be replaced with a new one only after breaking the vacuum (replacing the vacuum with nitrogen gas, see paragraph 5-10).

5-7.10. Inner Shell Relief Valve. The inner shell relief valve (RV-3) is a sealed (ASME Code) unit. Attempt no repairs or adjustments. If leaks are suspected (evidence is usually in the form of constant venting, frosted tubing, or the inability to achieve pressure buildup for product transfer), replace the valve, and dispose of it through normal channels. A method for testing the valve is outlined in Section VII.

5-7.11. Fill/Drain Service Line Relief Valves. Repair of these valves (RV-1, RV-2) should be limited to disassembly and cleaning. Replace the valve if the resilient seal is permanently deformed, cracked or otherwise damaged; or, if the mating surfaces are scored or pitted. Testing procedures for the determination of relief pressure appear in Section VII.

5-7.12. Rupture Disc Assembly. Failure of the inner shell rupture disc (SD-1) is usually indicated by a failure to achieve pressure buildup for product transfer, frosted vent lines and tubing, and constant venting not associated with the inner shell relief valve (RV-3) or the vapor vent line valve (V-8). Remove and replace the rupture disc assembly by uncoupling the rupture disc tube coupling nut from the assembly and removing the rupture disc from the coupling. Do not attempt further disassembly. It must be replaced with a new unit.

5-7.13. Fill/Drain and Service Line Filters. Filters should be cleaned or replaced whenever they appear to impede the flow of product. Procedures for the removal and replacement of the line filters appear in Section V of T.O. 37C2-8-33-1, Operation and Maintenance Instructions. Make sure that the flow arrow on the filter is pointed in the direction of liquid flow on reassembly. The fill/drain line filter

arrow must point inboard, the service line filter arrow must point outboard from the tank.

5-7.14. Gages. Defective gages (liquid level LL-1 and pressure PI-1) are easily removed from the control panel by disassembling the retaining nuts, washers, and machine screws and uncoupling the tubing couplings which attach them to the gaging system. Repairs are made with a drained and purged storage tank.

a. Gage bezels may be removed from either gage (by turning counter-clockwise) without isolating the gage from the system.

b. Calibration information for the storage tank gages and the management provisions for their maintenance is found in T.O. 37C11-1-1 and T.O. 33K-1-1-00. The local Precision Management Equipment (PME) laboratories are responsible for the maintenance of gage calibration, in accordance with the applicable 33K series of technical orders. Consult with the cognizant PME laboratory on forwarding any gage for calibration, and follow the directions for handling and packing.

5-8. WELDING.

Welding/cutting operations produce heat, metal fumes, injurious radiation, metal slag and airborne particles. Approved welder's safety equipment will be used. Ventilation requirements will be determined by the Base Bioenvironmental Engineer.

All welding on the storage tank shall be accomplished by certified welders in accordance with MIL-STD-1595, using standard welding practices and procedures (Refer to T.O. 00-25-252).

5-8.1. Storage Tank Outer Jacket. Although welding on the tank jacket is not normally recommended or accomplished on the base level, the method and information are included here to prevent work stoppage or mission delay. Do not attempt to weld on the tank jacket, piping or frame until the vessel has been drained, purged, and the annular space vacuum replaced by a nitrogen atmosphere (See paragraph 5-10).

All welding on the storage tank shall be accomplished by certified welders in accordance with MIL-STD-1595 using heliarc welding only (Refer to T.O. 00-25-252).

5-8.2. Tank Frame, Saddle and Skid Frame. Welding on frame members may be accomplished by an electrical method at any level of maintenance where qualified personnel and equipment are available.

5-9. BRAZING.

Manifold assemblies present the foremost example of brazed areas on the storage tank. All brazed connections must be joined using an alloy rod or wire containing a minimum of 50% silver; and, in conformance with Federal Specification QQ-B-654A, and a flux conforming with Federal Specifications O-F-499c.

5-10. BREAKING THE ANNULUS VACUUM (See Figure 5-1).

When repairs to the outer jacket or to piping must be performed which will affect the status of the annular space, the vacuum must be replaced with a nitrogen atmosphere. No positive pressure may be applied, and the gas must be drawn into the space according to the following procedures:

a. Remove the vacuum flange from the vacuum flange weldment at the rear of the storage tank (Figure 5-1).

b. Connect a source of low-pressure nitrogen gas (Specification BB-N-411, Grade B, Type 1) to the vacuum flange weldment. Regulate nitrogen source to 2 to 3 psig.

c. Open the nitrogen source service valve, and slowly open the vacuum valve and allow the nitrogen to be drawn into the annular space.

d. When the nitrogen flow stops, close the source supply valve, then close vacuum valve.

e. Disconnect the nitrogen source from the vacuum flange weldment.

f. Reinstall the vacuum flange on the vacuum flange weldment. Replace the o-ring if required.

5-11. STORAGE TANK ANNULUS EVACUATION (PUMPDOWN) (See Figure 5-1).

Some deterioration of annulus vacuum over a period

of time is normal. Consult periodic inspection records for an indication of this condition. As a warm storage tank will have a slightly higher pressure indication than a cold one, this condition does not necessarily indicate a vacuum loss. However, a sudden or rapid loss of vacuum may indicate leakage. A thorough and complete inspection will probably determine the cause. Do not attempt to evacuate the storage tank annular space until the cause of the vacuum loss has been determined, and, if necessary, repaired.

a. Determine the storage tank annulus vacuum level following the procedure referenced in Section VII, Testing. After the test, close the vacuum thermocouple valve (V-12).

b. Remove the vacuum flange from the vacuum flange weldment at the back of the storage tank, as shown in Figure 5-1.

c. Attach a vacuum line from the vacuum pump to the vacuum flange weldment and secure it with the bolts, washers, and nuts. Replace o-ring if required.

NOTE

The permanently installed thermocouple at the front of the storage tank is used to monitor the vacuum in the annular space.

d. Start the vacuum pump and read the vacuum level at the pump. It must be below 4 microns before the pump valve is opened. Record the vacuum level.

e. Do not shut-off the vacuum pump during evacuation. If power fails, or if the pump is accidentally turned off, close the vacuum valve immediately. Vacuum pump lubricant can be drawn through the hose and into the annular space, making further evacuation impossible and destroying the effectiveness of the insulation.

f. Always inspect the hose and valve after evacuation to be sure that no lubricant is in evidence. Do not confuse the appearance of the solid colorless oxygen-compatible grease used on vacuum system O-rings, which is safe; and, the light-brown, oily-appearing pump lubricant, which is unsafe. Vacuum loss due to oil ingestion will be immediate, and the storage tank must be condemned as unserviceable.

g. Slowly open the pump valve to the vacuum hose, and allow the pump to evacuate the hose for approximately ten (10) minutes. Record the vacuum level in the hose (determined by a vacuum gage installed in the hose). It should not be more than three (3) microns greater than the level recorded at the pump.

h. Open the vacuum valve slowly. There should be a rise in the hose vacuum level, this is normal.

i. After four (4) hours of pumping, there should be a large drop in the hose vacuum, indicating that there are no leaks in the system.

j. Observe and record the vacuum level indicated by a portable gage attached to the vacuum gage thermocouple at the front of the storage tank. The vacuum gage (Thermocouple isolation) valve must be opened to obtain this reading.

k. Continue to pump until the desired level is indicated on the portable gage (15 microns, warm; 1 micron, cold).

l. When the annulus is evacuated to the desired level, close the vacuum valve. Turn off the vacuum pump, open the vacuum line bleed valve and allow the vacuum hose to stabilize; the hose may then be disconnected from the operator port.

m. Using the portable gage attached to the thermocouple at the front of the tank; open the vacuum gage valve, and determine and record the vacuum level of the annular space. Then monitor the indication for two (2) hours. Watch for any pressure rise that might indicate a leak.

n. At the rear of the tank, remove the vacuum line from the vacuum flange weldment. Inspect the hose and the interior of the vacuum flange weldment for evidence of pump lubricant which may have been drawn into the area by the vacuum (See Step f). If there is no contamination, replace the vacuum flange on the vacuum flange weldment with the bolts, washers and nuts. Replace the o-ring if required. If there is contamination, clean the area with freon (See Table 2-2) and test for vacuum loss (Refer to Section VII). Vacuum loss will

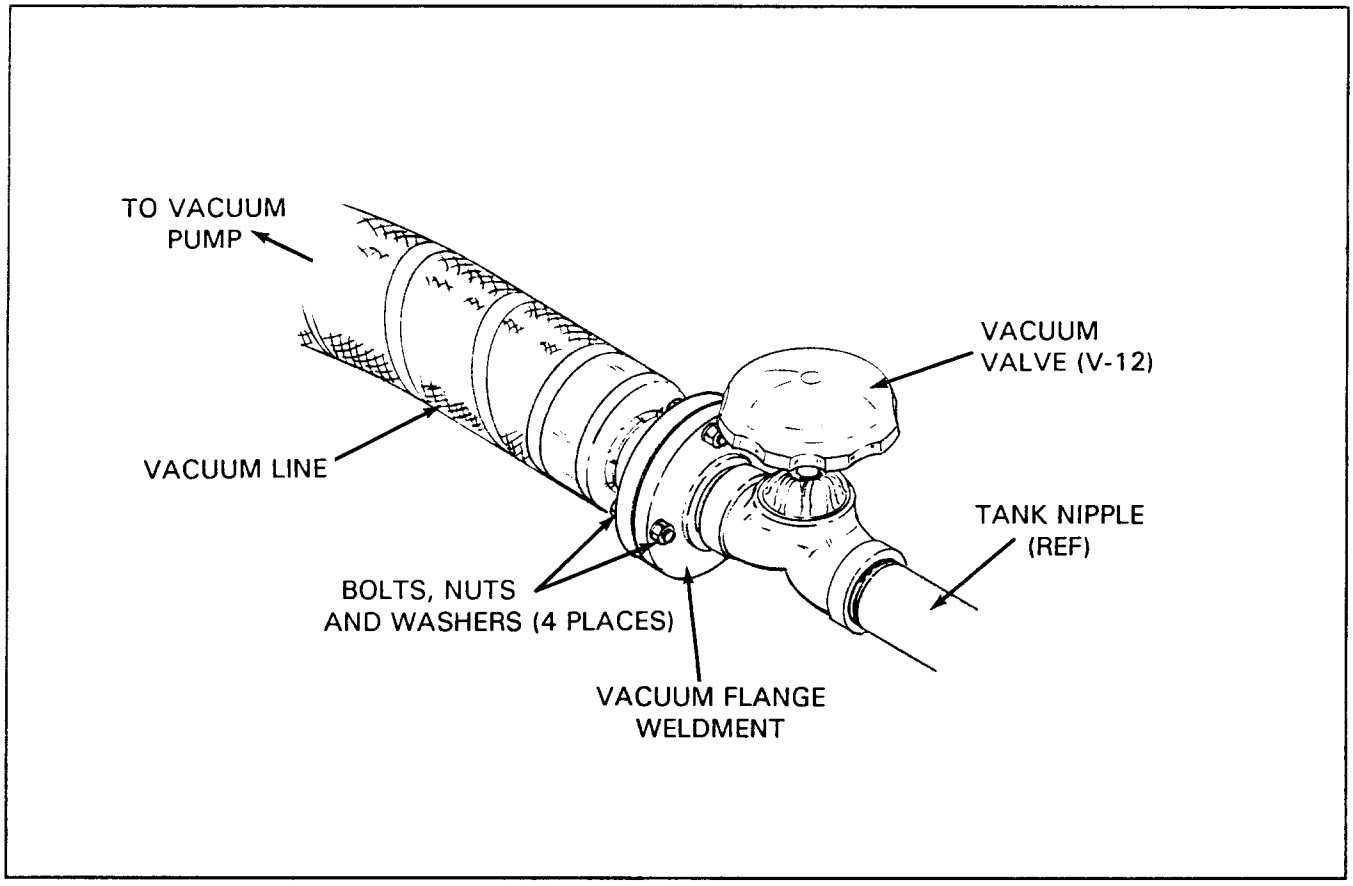


Figure 5-1. Evacuation of Annular Space using Vacuum Valve Assembly

be immediate if oil has been ingested, and the storage tank will be unserviceable.

o. When satisfied that the vacuum level has stabilized, and is within the appropriate limits, close the vacuum gage (thermocouple isolation) valve (V-12). Set the portable vacuum gage switch to OFF, and detach the gage lead from the thermocouple.

p. To avoid vacuum loss, make sure that the vacuum gage valve is tightly closed except when actually measuring the annulus vacuum level.

5-12. PAINTING AND MARKING.

Repair any damage to painted surfaces in accordance with MIL-STD-808 (USAF), Finishes, Protective, and Codes, for Finishing Schemes for Ground and Ground Support Equipment; and SA/ALC Drawing 7545352, Requirements for Finishes, Protective and Codes for San Antonio ALC Ground and Ground Support Equipment. These are for Type 1 finishes, giving protection for climatic elements. Application shall be made in accordance with the above-mentioned documents, and as follows:

a. Insure that all open ports on the tank are covered with plugs or polyethylene bags.

b. The basic painting materials are:

(1) Organic zinc primer in accordance with drawing 7545352.

(2) For storage tanks in liquid nitrogen service, the paint finish shall be polyurethane, in accordance with MIL-C-83286, and the color shall be gloss white, No. 17875, as specified in FED-STD-595A.

c. Unpainted Areas: Do not attempt to paint copper tubing and stainless steel manifolds.

d. Marking: External markings shall be in accordance with MIL-STD-130.

SECTION VI

ASSEMBLY

6-1. SCOPE.

This section contains assembly instructions for the storage tank, Liquid Nitrogen, Type TMU-35/E, 2000-Gallon. Testing instructions are outlined in Section VII, Testing, and will be referenced, as applicable, throughout the text.

6-2. PRECAUTIONS.

6-2.1. Cleanliness. Cleanliness is essential for all components in contact with the product.

6-2.1.1. Environmental Concerns. The storage tank should be assembled in an approved clean area. Parts, tools and the general environment shall be maintained with a high degree of cleanliness at all times. Any component which ordinarily comes in contact with the product shall be assembled only in a controlled environment, using extreme care to prevent contamination of the components.

6-2.1.2. Protection of Components. All plugged and bagged components shall remain so until ready for assembly. Assembled components shall be plugged or bagged until ready for installation on the tank. Components contaminated during calibration of component testing shall be recleaned before final installation. All overhaul personnel shall wear clean, white, lint-free gloves while assembling components which will come in contact with the product.

6-2.2. Prevention of Damage. Exercise care at all times during tank assembly to avoid damage or distortion of components. Only tools most suited for a particular application may be used. A suitable fixture, vise, or other type support shall be used to support all applicable components during assembly.

6-3. GENERAL INSTRUCTIONS.

6-3.1. Identification Tags. All temporary identification tags shall be removed during installation of the components.

6-3.2. Assembly of Threaded Joints and Fittings. Thread sealant (anti-seize) tape conforming to Specification MIL-T-27730 (Refer to Table 2-2) shall be applied to the male threads of all pipe-threaded fittings before assembly, except those pertaining to the vacuum system, which shall be noted. The tape shall be applied, starting with the third thread from the end of the fitting to prevent releasing tape particles into the system. Tape is to be wrapped in the direction of the threads.

6-3.3. Lubrication. No lubrication is to be applied to components during installation, except a small amount of stopcock grease, KEL-F-90 (Refer to Table 2-2), may be applied to the threads of the stainless steel flange bolts to prevent thread galling.

6-4. ASSEMBLY PROCEDURES.

6-4.1. Order of Assembly. The order of assembly of components of the storage tank is generally in the reverse order of disassembly described in Section III, and references are made to the illustrations in that Section. Torque values for threaded components are presented in Section VIII, Table of Limits. The assumption is made throughout this Section that assemblies have been completely disassembled, although this may not be the case, and most will have been disassembled only to the extent necessary to effect repairs.

6-4.1.1. Seal-Off (Vacuum Pumpdown) Valve Assembly (See Figure 3-9). Installation of seal-off valve components should not be attempted unless the annular space has been purged, and filled with dry nitrogen gas (Refer to Section V).

a. When replacing the valve plug (4) in the valve body (2), make sure that the internal threads of the plug are visible when it is installed, facing outboard. If the plug is installed backward, it can be difficult to remove.

b. Coat O-ring (3) with vacuum grease (Dow Corning DV6M, or equivalent) and place it on the plug (4). Insert the plug into the valve body (2). The plug may be installed with the fingers, or, by using the threaded shaft of the operating tool (Refer

to Table 2-1). If using the tool, thread the plug on the shaft, insert it in the valve body; then, unscrew the tool shaft, leaving the plug in place.

c. Test per paragraph 7-5.2.1.

d. Place the protective cap (1) on the valve body (2).

6-4.1.2. Thermocouple and Vacuum Gage Valve Assembly (See Figure 3-8). Installation of the thermocouple and vacuum gage valve should not be attempted unless the annular space has been purged and filled with dry nitrogen gas (Refer to Section V). These instructions are only offered as a method of replacement of parts following valve or thermocouple failure.

a. Apply vacuum sealing compound (Refer to Table 2-2) to the male threads, beginning one thread away from the end of the welded pipe nipple, and install vacuum gage valve (2) on the tank vacuum gage fitting. Tighten until firm, but do not over torque. The compound will provide sufficient sealing.

CAUTION

Do not use any tool to operate the vacuum gage valve. Over-tightening the valve knob will cause permanent damage.

b. Apply vacuum sealing compound to the male threads of the thermocouple tube (1), beginning one thread away from the end. Install the thermocouple on gage valve (2), (caution, do not over-torque).

c. Test per paragraph 7-5.2.1.

d. Make sure that the thermocouple valve (2) is closed.

6-4.1.3. Piping Assembly (See Figure 3-7).

a. Install filter (48). Make sure that the arrow on the filter is pointed away from the tank. Tighten the filter until threaded to a depth of approximately 11/16 inch.

b. Install u-bolt (45) around filter (48) and through the support bracket. Secure u-bolt with washers (47) and nuts (46).

c. Install nipple (44) on filter (48). Hold the filter securely with a suitable wrench and turn the nipple until it is threaded to a depth of approximately 11/16 inch. Make sure that the nipple compression nut is aligned to match elbow (40) and connect elbow (40) to the nipple (44) to facilitate globe valve (38) installation.

d. Install body of globe valve (38) with flow arrrow away from nipple (44) on elbow (40) and elbow (39) on valve (38). Install stem and bonnet assembly in valve (38) as per paragraph 6-4.1.8.

e. Install elbow (41), coupling (43), relief valve (42), and elbow (54) on nipple (44).

f. Install filter (35). Make sure that the arrow on the filter is pointed toward the tank. Tighten the filter until threaded to a depth of approximately 11/16 inch.

g. Install u-bolt (34) around filter (35) and through the support bracket. Secure u-bolt with washers (37) and nuts (36).

h. Install nipple (32) on filter (35). Hold the filter securely with a suitable wrench and turn the nipple until it is threaded to a depth of approximately 11/16 inch. Make sure that the nipple compression nut is aligned to match elbow (33) and connect elbow (33) to nipple (32) to facilitate globe valve (29) installation.

i. Install coupling (31), relief valve (30), and elbow (54) on nipple (32).

j. Install valve body of (29) with flow arrow away from nipple (32) on elbow (33) and nipple (28) and elbow (27) on valve (29). Install stem and bonnet assembly in valve (29) as per paragraph 6-4.1.8.

k. Install bushing (24) on nipple (32). Assemble coupling assembly and install it on bushing (24).

l. Install pipe nipple (18) and secure with u-bolt (20) and nuts (19).

m. Install globe valve body of (16) with flow arrow away from tank and elbow (17) on pipe

nipple (18). Install stem and bonnet assembly in valve (16) as per paragraph 6-4.1.8.

n. Assemble coupling assembly (9) and install it.

o. Connect tubes (4) at each end and secure with clamps (8), screws (7), washers (6) and nuts (5).

p. Carefully install PBU assembly (1) around tank and secure with brackets (3) and nuts (2). Connect vent piping assembly and fill/drain assembly to PBU assembly.

6-4.1.4. Cabinet Assembly (See Figure 3-6).

a. Carefully position cabinet in place and avoid damaging the thermocouple assembly and full trycock line. Secure cabinet with screws (49), washers (50), and nuts (51). (Refer to figure 3-7).

b. Install plates (28, 29, 30) to door and secure with rivets (31).

c. Install door latches (25) and secure with nuts (26) and screws (27).

d. Install hinge (18) on door (15) using screw (17) and nut (16).

e. Install door (15) with hinge (18) and bracket (21) on cabinet and secure with screws (20) and nuts (19). Secure bracket with screws (24), washer (23), and nut (22).

f. Install door latch (12) on door and secure with screws (14) and nuts (13).

g. Install door keepers (9) on door and secure with screws (11) and nuts (10).

h. Connect all connections, tubes and tube clamps from cabinet to tank.

i. Replace fill/drain line assembly as per paragraph 6-4.1.5.

j. Replace instrumentation panel as per paragraph 6-4.1.7.

k. Replace vent piping assembly as per paragraph 6-4.1.6.

6-5.1.5. Fill/Drain Line Assembly (See Figure 3-5).

a. Install valve body (5) on fill/drain line segment (6) with flow arrow away from line segment (6).

b. Screw elbow (4) into valve (5) and nipple (3) into elbow (4).

c. Install valve body (2) on fill drain line segment (6) with flow arrow away from line segment (6).

d. Connect PBU segment (1) to valve (2) using screwed segment of union. Connect PBU ends to PBU segment (1). (Refer to figure 3-7).

e. Install fill/drain line filter and attaching components, reference 6-4.1.3.

f. Replace stem and bonnet assemblies on valves (2, 5) as per paragraph 6-4.1.8.

6-4.1.6 Vent Piping Assembly (See Figure 3-4).

a. Install valve body (5) and nipple (6) onto vent piping subassembly (7) and screw elbow (4) into valve (5).

b. Install rupture unit (2), elbow (1) and relief valve (3) on vent piping subassembly (7).

c. Carefully position assembly through side of cabinet and secure with u-bolt (10), plate (9), washers (9) and nuts (8). Prior to installing vent assembly, valve stem and bonnet assemblies for valves V-8, V-6, V-9, V-5, and V-4 must be removed for clearance.

d. Connect each end of subassembly (7).

e. Install nipple (12) and elbow (13) through back of cabinet.

f. Connect connector (14) to vent tube.

g. Replace top cover of panel.

h. Install stem and bonnet assemblies into valves, V-8, V-6, V-9, V-5, V-4 as per paragraph 6-4.1.8.

6-4.1.7. Instrumentation Panel Assembly (See Figure

3-3).

a. Install identification tags (25) on panel (27) and secure with rivets (26).

b. Position pressure gage (24) in panel (27) and secure with screws (23), washers (22) and nuts (21). Install cover (18).

c. Position liquid level gage (19) in panel (27) and secure with screws (17), washers (16) and nuts (15). Install cover (18).

d. Install elbow (20) and tee (14) on liquid level gage (19).

e. Install elbow (13) on pressure gage (24).

f. Connect tube (12) between elbow (13) and tee (14) and tighten tube nuts on tube.

g. Install pressure control valve (11) through panel (27) and secure with nut (10).

h. Install wing nut and knob (9) on valve (11) and secure with setscrew (8).

i. Screw connectors (7) into valve (11).

j. Install union (3) through panel and secure with nut (2). Install cap (1) on union (3).

k. Connect tube (5) between union (3) and tee (6) and tighten tube nuts. Connect other tube (5) between tee (6) and connector (7) and tighten tube nuts.

l. Install panel (27) in control housing and secure with 7 screws (52, Figure 3-7) and nuts (53, Figure 3-7) on side and rear of panel.

m. Install top cover on control housing.

6-4.1.8. Globe Valve Assembly (See Figure 3-2).

a. Using the appropriate special wrench (refer to Table 2-1), install seat (15) in valve body (16).

b. Install disc locknut (13) on valve stem (14) and lock it in place with horseshoe ring (12).

c. Holding locknut (13) with a suitable wrench, screw on disc holder (11).

d. Install disc insert (10) and disc plate (9) and secure with disc nut (8).

e. Insert stem (14) into valve bonnet (7) and turn it counter-clockwise to engage the stem threads with those on the bonnet. Install bonnet nut (6) on bonnet (7).

f. Place packing (5) on valve stem (14) and push it down into the bonnet. Then place packing gland (4) on the stem and push it down to cover the packing.

g. Install packing nut (3) on stem.

h. Do not over-torque the packing nut. Turn it clockwise until it is firm. The packing nut area must be leak-checked, and the nut tightened to prevent leaks when pressure is applied to the system during testing (See Section VII).

i. Place the stem/bonnet assembly on valve body (16). Engage the bonnet nut with the threads at the top of the body and tighten with a suitable wrench.

j. Do not over-torque the bonnet nut. This is a metal-to-metal connection, and can be damaged by excessive tightening. This area must be leak-checked when pressure is applied to the system; and then, tightened to stop any leaks.

k. Install handwheel (2) on top of stem (14) and secure it with nut (1).

6-4.1.9. Service Hose Assembly (See Figure 3-1).

a. If the service hose coupling assembly (2) has been completely disassembled, reassemble the coupling nut (4) with the coupling cone (5) and secure them together by placing the coupling retaining ring (3) in the cone ring groove.

b. Place the coupling (2) on nipple (6) and turn it clockwise until threaded to a depth of approximately 11/16-inch.

c. Holding the hose in a vertical position, place its female adapter on the male threads of the service elbow and turn it clockwise until threaded to a depth of approximately 11/16-inch.

6-4.1.10. Vacuum Line Shut-off Valve Assembly. (See Figure 3-10). Installation of Vacuum line shut-off valve components should not be attempted unless the annular space has been purged, and filled with dry nitrogen gas (Refer to Section V).

a. Apply vacuum sealing compound (Refer to Table 2-2) to male threads on nipple on the tank.

b. Screw vacuum valve (1) onto nipple on tank. Tighten the vacuum valve until threaded to a depth of approximately 11/16 inch.

c. Apply vacuum sealing compound (Refer to Table 2-2) to male threads on flange weldment (2).

d. Screw flange weldment (2) into the vacuum valve (1). Tighten the flange weldment until threaded to a depth of approximately 11/16 inch.

e. Coat o-ring (3) with vacuum grease (Dow Corning DV6m, or equivalent) and place it in the o-ring groove in the flange weldment (2).

f. Install the vacuum flange (4) on the flange weldment (2). Secure with nuts (5), washers (6) and bolts (7).

g. Test per paragraph 7-5.2.1.

SECTION VII

TESTING

7-1. SCOPE.

This section contains procedures for testing individual components, as well as tests to be performed after repairs and reassembly of the storage tank have been accomplished.

7-2. PRECAUTIONS.

All of the following precautions must be observed by personnel conducting the tests outlined in this section. All persons operating this storage tank must be thoroughly familiar with the hazards involved in the handling of liquid nitrogen.

7-3. EQUIPMENT OPERATIONAL SAFETY.

The storage tank presents several peculiar hazards which must be addressed by the operator. While the equipment and products are not dangerous in themselves, failure to observe normal precautions can lead to serious injury to personnel and severe equipment damage.

7-3.1. Static Grounding. A static grounding lug is installed at the rear of the storage tank for the attachment of a grounding cable. It must be attached to proper ground during testing and operation.

7-3.2. Relief and Vent Valves. Personnel must be constantly aware that vapor or liquid product may be vented from the system at any time. The vapor vent line directs discharged gas down and away from the control housing. It must be clear of all obstructions, including plugs, tape and external blockages.

7-3.3. Control Valves. The manual control valves are installed on the control panel, exposed by opening the front door of the control housing. They should be operated in the manner indicated in T.O. 37C2-8-33-1, Operation and Maintenance Instructions.

7-3.4. Confinement of Product. Never confine the liquid product in any piping or closed container. This creates an extremely dangerous "pipe bomb" condition as the product expands to gas, creating a tremendous pressure in the confined space.

7-4. MEASUREMENTS AND INSTRUMENTATION.

7-4.1. Accuracy of Measurements. All apparatus used in testing shall be of laboratory precision type as far as practicable, and shall be calibrated at intervals properly spaced to continue laboratory accuracy.

7-4.1.1. Gage Pressures. Data on gage pressures measured in the range from 0 to 100 psi shall be accurate to within two (2) percent of full scale.

7-4.1.2. Weight Measurements. Data on product measurements obtained by scale weights of the storage tank and the product shall be accurate to within five (5) percent.

7-4.1.3. Gas Flow Rates. Data on gas flow rates shall be accurate to within three (3) percent.

7-4.2. Instrumentation.

7-4.2.1. Tank Pressures. Tank pressures above the atmospheric pressure shall be measured by the tank pressure gage (PI-1) on the control panel.

7-4.2.2. Liquid Level. The storage tank liquid content shall be measured by the liquid level gage (LL-1) on the control panel, or by weighing the entire unit. Weighing should be measured by scales designed for this particular type of measurement and shall be recorded in pounds (which may then be converted to gallons). The liquid level gage will not present an accurate indication during filling, draining or pressure buildup operations due to pressure surges. Allow the product to stabilize before recording indications from the liquid level gage.

7-5. TESTING PROCEDURES.

7-5.1. Cleanliness Testing. Refer to Section V,

Paragraph 5-6 for inspection of both the interior and exterior of the storage tank.

7-5.2. Leak Detection. Leakage, internal and external, is often indicated by observation. Thus, frosted piping presents evidence that product is escaping through a valve; cold spots on the tank jacket are indicative of a possible vacuum leak; and, a frosted valve stem can be caused by a worn packing or a packing nut that needs to be tightened. These symptoms and suggested remedies are displayed in the Trouble Shooting Table (Section V, in T.O. 37C2-8-33-1). However, very small leaks, such as a loss of 10 to 50 microns of vacuum per day, cannot be detected or repaired by ordinary methods.

7-5.2.1. Vacuum Leak Detection. Vacuum leak detection requires contractor or depot facilities, trained and experienced personnel, and the employment of helium mass spectrometer equipment. The method is outlined below for general information:

a. The inner vessel must be drained of all liquid product and be at ambient temperatures before any testing.

b. Leakage of the inner vessel into the annular space will generally be indicated by the seal-off valve plug being forced out of the valve body. This type of leak cannot be field-repaired.

c. Attach a seal-off valve operator (See Figure 5-1) to the seal-off valve body, and attach a mass spectrometer leak detector (See Table 2-1) to its vacuum outlet. Using a vacuum pump, evacuate the line from the spectrometer to the valve operator.

d. Open the seal-off valve to connect the annular space vacuum to the mass spectrometer.

e. Use a helium jet spray to check all welded seams between the inner and outer vessel and jacketed piping. Keep the spectrometer remote control sensor close at hand for quick leak detection.

f. Report leaking weldments to the proper authority. Do not perform make-shift repairs. See Paragraph 5-8.

g. When leak testing is complete, close the seal-off valve, and remove the spectrometer tube from the operator. Remove operator from valve body.

NOTE

The technique for determining the level of vacuum in the annular space is outlined in Section V of T.O. 37C2-8-33-1, using vacuum gage assembly NSN 6685-00-115-9602YD (Refer to Table 2-1).

7-5.2.2. Pressure Leak Detection. Pressure leak detection consists primarily of pressurizing the piping system, and making a "bubble test" with Leak Detection Compound (MIL-C-25567C, refer to Table 2-2).

a. Attach the storage tank to a regulated source of clean, dry nitrogen gas (Specification BB-N-411, see Table 2-2) through the fill/drain coupling (or, having removed the coupling and making direct attachment through the fill/drain nipple assembly. Open the fill/drain shut-off valve (V-6) and regulate the gaseous nitrogen pressure to 50 psi (as noted on both the nitrogen source gas gage and the tank pressure gage).

b. Following the instructions packaged with the leak detector compound, apply the compound to each threaded joint, the bonnet and packing nuts, and paying particular attention to fittings to the gage.

c. Tighten plumbing joints to stop leaks. If tightening fails to stop the leaks, disassemble and determine the cause of the problem. Check valve seats and plug assemblies, replacing parts as necessary. Make sure that all threaded joints are sealed with anti-seize tape (Refer to Table 2-2).

d. After all repairs have been made, pressurize the tank to 50 psi and allow it to stabilize for 24 hours at constant temperature. Check gages for pressure loss. If pressure loss is excessive, recheck for leaks. Temperature changes can cause slight variations in tank pressure and must be considered.

7-5.3. Evaporation Loss Testing. This test will determine the adequacy of the insulation and vacuum in the storage tank annular space. This is accomplished by measuring the evaporation loss rate at ambient temperature and pressure.

7-5.3.1. Volume Method. This procedure requires the use of a totalizing flowmeter (Refer to Table 2-1), usually available from the PMEL or Fuels Laboratory.

a. Fill the storage tank to 50% capacity (1000 gallons) and allow the liquid to stabilize for a minimum of twenty-four (24) hours, passing all vapor through a totalizing flowmeter.

b. Record the volume of vapors which have flowed through the meter and calculate the weight of the evaporated product. It must not exceed 75 pounds.

c. Disconnect the flowmeter and return valve to its normal condition.

7-5.4. Vacuum Retention Testing. This test is related to both the leak testing and evaporation loss testing procedures, and is a supplementary verification of their results.

a. Fill the storage tank with not less than 1200 gallons of liquid product, and allow it to stabilize for a minimum of twenty-four (24) hours.

b. Following the techniques outlined in Section V of T.O. 37C2-8-33-1, Operation and Maintenance Instructions, using a vacuum gage (Refer to Table 2-1), determine the vacuum level of the annular space.

c. Permit the storage tank to remain undisturbed for a minimum of one hundred and sixty-eight (168) hours (7 days), and then repeat the test of paragraph b. The annular space absolute pressure shall not exceed 35 microns H_g or show any increase in pressure attributable to outgassing or leaks.

7-5.5. Relief Valve Testing. The line relief valves (RV-1 & RV-2) may be tested by attaching them to a regulated source of dry nitrogen gas, and increasing the pressure until they open to relieve. The tank pressure relieve valve (RV-3) may be tested by increasing the pressure in the storage tank (using the pressure buildup valve) and noting the pressure at which the valve relieves; or by removing the valve from the vapor vent manifold and testing it in the same manner as the line relief valves.

CAUTION

Do not attempt to adjust any of the relief valves. The tank pressure relief valve is a sealed, ASME-Code-certified unit. Do not tamper with it.

7-5.5.1. Line Relief Valves. Line relief valves (RV-1, RV-2) should relieve at 75 ±5 psig, and reseat at between 60 psig and 2 psig less than the opening pressure.

7-5.5.2. Inner Shell Relief Valve. The inner shell relief valve (RV-3) should relieve at 60 ±5 psig, and reseat between 48 psig and 2 psig less than the opening pressure.

SECTION VIII

TABLE OF LIMITS

8-1. SCOPE.

This section consists of a Table of Limits (Refer to Table 8-1), applicable to the equipment covered by this manual. Maximum and minimum limits refer to clearances, torques, pressures, etc., beyond which the item may not be continued in service.

Table 8-1. Table of Limits

Item Description	Limits
#10 Machine Screws/Nuts	Torque 21 to 27 in/lbs.
1/4-Inch Machine Screws/Nuts	Torque 50-66 in/lbs
3/8-Inch Machine Screws/Nuts	Torque 15 to 20 ft/lbs.
Tank (Safety) Relief Valve	Set at 60 ±5 psig.
Line Relief Valve (2)	Set at 75 ±5 psig.
Rupture Disc	Rated at 91 psig +9/-5 psig.

SECTION IX

ILLUSTRATED PARTS BREAKDOWN

9-1. ILLUSTRATED PARTS BREAKDOWN.

The Illustrated Parts Breakdown for the storage tank is contained in T.O. 37C2-8-33-4.

SECTION X

DIFFERENCE DATA SHEETS

Not Applicable